ADI Limited
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Open File Report 89-38

INDUSTRIAL MINERAL PRODUCTION AND CONSUMPTION IN NEW BRUNSWICK

VOLUME 3

INDUSTRIAL MINERALS USED PRIMARILY IN THE CHEMICAL AND PULP AND PAPER INDUSTRIES

by

ADI Limited
Fredericton, New Brunswick

Canada-New Brunswick Mineral Development Agreement
Entente Canada-Nouveau-Brunswick L'Exploitation Minérale

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Copies available by contacting:

Minerals and Energy Division
Department of Natural Resources
and Energy
P. O. Box 6000, Fredericton
New Brunswick E3B 5H1

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PREFACE

From 1985-1989, the Province of New Brunswick, in conjunction with the Government of Canada, has initiated a number of mineral commodity studies through the Economic Development Program established under a Federal-Provincial Mineral Development Agreement. An important part of this agreement has involved studies designed in part to provide important marketing information on selected industrial minerals. These market-related projects have tended to concentrate on potential market growth areas primarily in North America, and particularly in areas where a New Brunswick producer could be competitive.

Whether it be building stone from Shediac, gypsum from Hillsborough or limestone from Saint John, industrial minerals have historically been important contributors to the economic growth and prosperity of New Brunswick. Today, industrial minerals are still important. Potash mining generates millions of dollars of salaries and business in the Sussex area, while the processing of phosphate rock with by-product sulphuric acid from a nearby lead smelter is a major industry in the Belledune-Bathurst region.

Preliminary figures for the value of industrial mineral production in New Brunswick was about $251 000 000 (Cdn) in 1988 compared to $197 000 000 in 1987. This represents an increase of twenty-two (22) percent. In 1988, industrial mineral production accounted for 31 percent of the total value of Provincial mineral production.

The manufacturing sector of the Province and surrounding areas consume substantial quantities of industrial minerals and their derived chemicals. Changing technology is making new demands on both the quality and quantities of industrial minerals consumed in the region. The requirement to document industrial mineral production in the Province as well as the consumption of these mineral commodities both, in the Province and adjacent areas, is becoming an increasingly important facet of responsible resource management.

Keenly aware of the importance of industrial minerals, the New Brunswick Department of Natural Resources and Energy has sponsored a review of industrial mineral supply and demand for New Brunswick (exclusive of granular and bedrock aggregate). The review was conducted under contract by ADI Limited and Three-D Geoconsultants Limited.

The purpose of the study is to provide as comprehensive and contemporary information as possible concerning the state of the industrial minerals industry in New Brunswick from both a producer's and consumer's point of view. Towards the achievement

of this goal, an assessment of the current supply/demand situation in the Province and adjacent reasonably accessible market areas was undertaken in an attempt to identify potential opportunities for market expansion and future development of indigenous industrial mineral resources. Another study objective is to indicate to various manufacturing industries where sources of various industrial mineral products are located in New Brunswick. Such an approach may be of some value in attracting new manufacturing industries to the Province. In addition, an attempt has been made to identify and document local market opportunties by showing producers where, in what quantities and under what circumstances industrial minerals and industrial mineral-based chemicals are being utilized within the Province and immediate surrounding areas.

Although this study focused primarily on the supply and demand of industrial minerals and industrial mineral-based chemicals produced and consumed in New Brunswick, the demand for similar products in market areas considered reasonably accessible to a local producer were also evaluated to some extent.

The results of the review were issued in the spring of 1989 and consist of a six volume report. Volume 1, 2 and 3 detail the history of specific industrial mineral production and consumption in New Brunswick and current demand within a market place easily accessible from the Province. Volume 4 provides demand projections for key industrial minerals, and describes the possible effects on future demand from environmental, technical, and other developments. Finally, Volumes 5 and 6 include a directory of New Brunswick's industrial mineral producers and consumers of industrial minerals within economic shipping distance of New Brunswick.

Component volumes of this extensive study are listed below:

Volume	Title	Open File Report
1.	Industrial Minerals Used Primarily in the Fertilizer Industry	89-36
2.	Industrial Minerals Used Primarily in the Construction Industry	89-37
3.	Industrial Minerals Used Primarily in the Chemical and Pulp and Paper Industries	89-38
4.	The Future of Industrial Minerals: General Trends in Consumption and Transportation	89-39
5.	Directory of New Brunswick Industrial Mineral Producers	89-40

Volume	Title	Open File Report
6.	Directory of Consumers of Industrial Minerals in Eastern Canada and the Northeastern United States	89-41

This volume addresses those selected industrial minerals consumed primarily in the chemical and pulp and paper industries - limestone/dolomite/lime, salt, diatomite, graphite, kaolin, barite, beryllium, feldspar, manganese dioxide and titanium dioxide.

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BARITE

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BARITE

1.0 INTRODUCTION

Definition. **Barite** or barium sulphate ($BaSO_4$) is the most commonly mined barium mineral. Other barium minerals such as **witherite** or barium carbonate ($BaCO_3$) and **sandbornite** or barium silicate ($BaSi_2O_5$) rarely occur in commercial concentrations. (B1)

Special properties. The following properties make barite a valuable industrial mineral; it is:

1. the primary source of barium (58.8% of barite is barium);
2. a heavy mineral (specific gravity of 4.5);
3. relatively insoluble in water and acid;
4. a low abrasive mineral;
5. non-magnetic;
6. non-toxic; and
7. an excellent pigment with no absorption or scattering of light. (B1, B2)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Barite is not mined in New Brunswick; however, it is found at a number of localities throughout the Province. (B4, B5, B6) In the Memramcook area of southeast New Brunswick, an occurrence has been periodically explored. At nearby Taylor Village a zone up to 25 m wide containing both barite and celestite has been traced for a lateral distance of about 1000 m. Active exploration and development is not being undertaken at present.

3.0 CONSUMPTION

Uses and quantities. In 1986, the reported Canadian consumption of barite was 0.022 tonnes (M) divided into the following applications:

Well drilling muds	0.015 tonnes (M)	68%
Paint and varnish	0.001 tonnes (M)	5%
Other (including plastics, bearings and brake linings, foundries, chemicals, explosives, glass, etc.)	0.006 tonnes (M)	27%

Consumption has declined dramatically since 1984 when total consumption was 0.072 tonnes (M) of which well drilling applications accounted for 0.064 tonnes (M) or almost 90 percent of consumption. Consumption by the paint and varnish industries and other uses has remained relatively steady. (B1)

American consumption of barite in 1986 was 1.105 tonnes (M) comprised of 0.997 tonnes (M) used in well drilling muds and 0.108 tonnes (M) used for chemicals, fillers, extenders, and glass. Again, consumption has declined dramatically: in 1981, 4.300 tonnes (M) of barite was consumed in the United States. (B2)

3.1 Drilling Muds

Description. Barite, because of its high specific gravity, is used as a weighting agent in drilling muds. It is mixed with clay (bentonite), water, and various additives in varying proportions depending upon the well drilling situation. A general rule of thumb is the deeper the well, the higher the concentration of barite in the mud.

Drilling muds are intended to lubricate and cool the drilling bit, carry drill cuttings to the surface, seal well walls, and confine the high pressures of gas and oil (see also "Bentonite"). (B1, B2)

Companies and locations. See Bentonite.

Sources and suppliers. There are only two sources of barite in northeastern North America:

1) Extender Minerals of Canada Limited in Matachewan, Ontario has a plant with a capacity of 13 500 tonnes per year. The product is sold mainly as a filler and extender.

2) Nystone Chemical Limited of Brookfield, Nova Scotia has a plant capacity of 15 000 tonnes per year. Its production is sold mainly for pharmaceutical uses.

Both of these firms could supply the well drilling market if market demand increased. At present, all barite suppliers for drilling mud are west of the Red and Mississippi Rivers.

Specifications. For drilling muds, barite should have a specific gravity of at least 4.2, a purity of 92-94 percent $BaSO_4$, a particle size less than 325 mesh (90-95 percent minus) and a maximum of 250 mg/L soluble alkaline earths, measured as calcium.

Prices. See Table 1.

Substitutes. The use of barite in drilling muds seems to be secure.

TABLE 1

PRICES FOR BARITE IN THE UNITED STATES (B1, B3)

Type	$(Cdn)/tonne	Date
Unground, chemical and glass grade, hand picked 95% $BaSO_4$, not over 1% Fe	$132	December 1987
Magnetic or flotation, 96-98% $BaSO_4$, not over 0.5% Fe	170	December 1987
Imported drilling mud grade, specific gravity 4.20-4.30, c.i.f. Gulf ports	38-57	December 1987
Dry-ground, southern, off-colour, coarse, bags, carload, f.o.b. works	265	July 1988
Wet-ground, white, bags, carload, f.o.b. works	380	July 1988
Unbleached, extra-fine, pigment grade, carload, f.o.b. works	230	July 1988

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BERYLLIUM

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BERYLLIUM

1.0 INTRODUCTION

Definition. Beryllium is a metallic element. It is grey, corrosion-resistant, light (specific gravity of 1.85), and relatively rare. Almost all beryllium comes from two minerals: beryl (3 $BeO.Al_2O.6\ SiO_2$) and bertrandite ($Be_4Si_2O_2(OH)_2$). Only three countries - the United States, China, and Russia - produce beryllium products from ores and concentrates. (Bm1, Bm2)

Special properties. According to the United States Bureau of Mines and Minerals "beryllium, in a span of 60 years, has become a necessary industrial mineral." It has several important properties including:

1) light weight. Beryllium is one of the lightest metals with a specific gravity between aluminum and magnesium.

2) high tensile strength.

3) very high strength-to-weight ratio.

4) great stiffness.

5) good electrical and thermal conductivity.

6) ability to moderate and reflect nuclear reactions.

7) high melting point (1290°C).

Beryllium is a very useful alloy element in particular, with copper, nickel, aluminum and magnesium.

Beryllium oxide forms useful ceramics exhibiting:

excellent insulation properties;
high thermal conductivity;
thermal shock resistance;
great hardness;
light weight; and
transmission of microwave radiation.
(Bm1, Bm2, Bm3)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Occurrences of beryllium in the Province have recently been reviewed. (BM4) An occurrence in the Zealand Station has recently been extensively explored and possible ore reserves of 147,000 tonnes grading 0.74% BeO are estimated. Other occurrences are also regarded as having potential and worthy of exploration.

3.0 CONSUMPTION

Uses and quantities. It is estimated that total world production of beryllium is only 200-300 tonnes per year. As well, much of the production goes to classified uses such as the military and aerospace agencies. Thus, it is not surprising that consumption data is general and not detailed.

In the United States in 1985 an estimated 65 percent of beryllium consumption is used in the production of beryllium-copper and other master alloys. These alloys are used in the construction of material test and mobile reactors and defense applications. A further 20 percent of consumption is for metal for use in the aerospace industry and 15 percent as beryllium oxide.

In 1983, American consumption was estimated to consist of 40 percent for nuclear reactors and aerospace, 36 percent for electrical equipment, 17 percent for electronic equipment and 7 percent for miscellaneous uses.

3.1 Beryllium Alloys

Description. Beryllium improves the properties of many metals when added as an alloying element.

In copper, beryllium is added at proportions of 0.3 to 2.0 percent. The resultant alloys (Be-Cu) are much stronger and harder than pure copper and have good corrosion resistance, and low magnetic susceptibility. The alloys are produced in a number of different shapes. Among the uses of the alloys are springs for mechanical and electro-mechanical devices, electrical devices such as connectors, sockets, contacts, and relays; diagrams, dies and molds, non-sparking tools, bushings, welding tips, and others.

Beryllium-nickel (Be-Ni) alloys have properties similar to Be-Cu alloys but can be used at higher temperatures. Uses include miniature electronic connector components, springs, mechanical fasteners, surgical tools, and tools for glass fabrication.

Beryllium-aluminum (Be-Al) and beryllium-magnesium (Be-Mg) alloys are easier to fabricate than either pure aluminum or pure magnesium. In addition the alloys have improved corrosion resistance.

Other, potential alloys include beryllium in stainless steel (Bm1, Bm2).

Companies and locations/sources and suppliers. In North America, the major suppliers of beryllium-copper alloys, beryllium metal, and beryllium oxide are:

Brush Wellmen Inc.

- Spor Mountain, VT (mine)
- Delta, VT (beryllium hydroxide mill)

Brush Wellman Inc. is the sole primary producer of beryllium in the United States.

NGK Insulators of Japan

- Reading, PA (beryllium-copper and other alloys)
- Athens, TN (foundry)
- Elkhart, IN (service centre)
- Elmsford, NY (service centre)

Inco Alloys International (Division of Inco Ltd.)

- Elkhart, IN (beryllium-copper alloy cold strip mill)

Cyprus Minerals Co. in joint venture with Cabot Corp.

- Sierra Blanca, TX (mine)

Emery Energy Inc. in joint venture with Cominco Ltd.

- Juab County, VT (mine and beryllium oxide mill)

(Bm1, Bm2, Bm3)

Specifications. The United States stockpiles beryllium as an essential material and has specifications governing acceptable material.

- beryllium-copper master alloy must contain between 3.75 and 4.5 percent by weight of beryllium with the balance being copper. Other elements must not total more than 0.72 percent by weight.

- beryl concentrates must not have less than 10 percent beryllium oxide by weight.

- beryllium metal must contain at least 98 percent by weight of beryllium with no more than 1.5 percent by weight beryllium oxide and 0.73 percent, other elements. (Bm2)

Prices. See Table 1.

Substitutes. According to the United States Bureau of Mines "substitutes can be used for beryllium metal, alloys, and beryllium oxide ceramics in some applications, but such use usually results in substantial downgrading of performance." For Be-Cu alloys, phosphor bronze substitution is possible, for example, but conductivity, fatigue and formability properties are inferior.

TABLE 1

PRICES FOR BERYLLIUM MATERIALS IN 1986 (Bm1, Bm3)

Type	$(Cdn)
Beryl ore; cif Atlantic - Ports 10% to 12% per Stu. (Eff. 19/4/82)	$13.20-$19.10/kg
Beryllium oxide Uox powder GCR, GCHG (Brush Wellman) (Eff. 2/1/85)	$163.00/kg
Beryllium containing alloys (4% BeCu)	
275 C BeCu casting alloy (1/9/86)	$16.70-$19.70/kg
165 C BeCu casting alloy (1/9/86)	$15.90/kg
245 BeCu casting alloy (1/9/86)	$16.00-$18.00
10 C BeCu casting alloy (30/06/86) (containing less than 0.5 percent Mg)	$14.70-$15.90/kg
Per kg contained beryllium (1/9/86)	$445.00/kg
Beryllium 97%	
Powder blend (200 grade), per kilogram 2270 kg lots (Eff. 10/1/85) Vac. cast ingots (Eff. 10/1/85) f.o.b. Elmore, Ohio	 $570.00 $660.00
Beryllium aluminum (30/6/86)	
f.o.b. Reading, PA, Detroit and Elmore, OH (45 500 kg)	$727.00 kg
Beryllium copper (1/9/86)	
Strip (No. 25)/kg Rod, bar and wire (No. 25)/kg	$22.40 $23.70
Beryllium copper master alloy	
f.o.b. Reading, PA, Detroit Michigan, Elmore, Ohio per kg contained beryllium for 2.3 kg ingot (Eff. 1/9/86)	$445.00

+ Beryllium copper alloys reflect a $290 per kilogram base copper price. Prices fluctuate weekly based on a predetermined copper composite price chosen by the individual companies.

3.2 Beryllium Metal

Description. It is difficult to cast beryllium because of the formation of coarse crystals. Rather, powder metallurgy is used with the ingots formed by compacting beryllium under heat and pressure in a vacuum.

Companies and locations/sources and suppliers. See "Beryllium Alloys".

Specifications. See "Beryllium Alloys".

Prices. See "Beryllium Alloys".

Substitutes. Steel or titanium can be used to replace beryllium in some structural applications. In nuclear applications it can be replaced by graphite but none of these substitutions threaten the beryllium market. A more serious threat is from composite materials such as those containing boron and graphite fibres. These materials have the same strength, stiffness and weight advantages of beryllium.

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DIATOMITE

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DIATOMITE

1.0 INTRODUCTION

Definition. Diatomite is a siliceous, sedimentary rock formed from the skeletal remains of tiny plants called diatoms. Diatoms are one cell organisms related to algae and found in either fresh or salt water. They extract silica from the water and then secrete it to form their skeletons.

Commercial diatomite deposits are the result of many thousands or millions of years of accumulation. The primary mining regions of the world are on the west coast of the United States and in western Europe. (D1)

Special properties. Diatomite is useful because of its chemical inertness and unique physical properties. The diatom skeleton provides unusual filtering properties, capable of removing very fine suspended material from liquids without affecting the characteristics of the liquid. High surface area per unit volume and low bulk density (90% voids) enhance filter applications by reducing the required frequency of backwashing and the weight of material. (D1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

A small amount of diatomite has been produced in the Sussex area in the early 1950s (near Mechanic Lake). At least 27 occurrences are known throughout the Province (D4, D5) but active exploration or development is not currently being undertaken.

3.0 CONSUMPTION

Use and quantities. Presented below are the principal consumption categories for diatomite in the United States. (D2)

Category	% of Consumption				
	1982	1983	1984	1985	1986
Fillers	19	21	22	21	17
Filtration	68	66	67	66	67
Insulation	1	3	1	1	3
Other (including abrasives, absorbents, additives, and silicate admixtures	12	10	10	12	13

See Figure 1.

Although comparable figures are not given for Canadian production, it is likely that the consumption pattern is similar.

3.1 Filtering

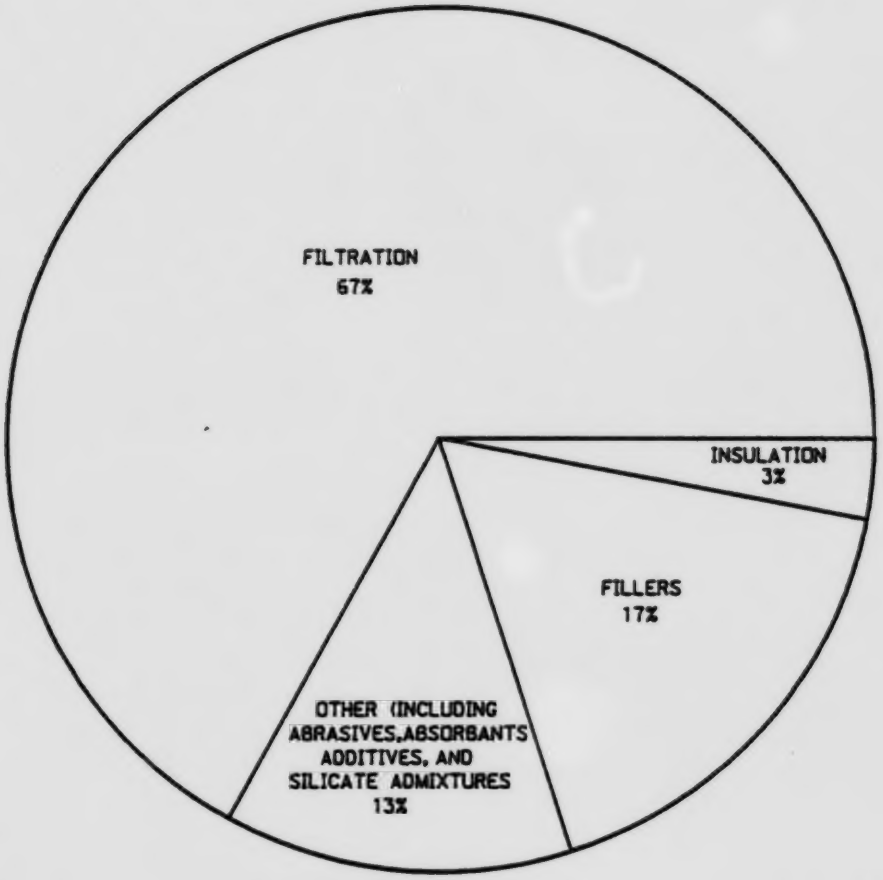
Description. Diatomite can remove suspended material as small as 0.1 micron (0.001 millimetres) from liquids without slowing liquid flow. For some applications, flux-calcined diatomite is used; the calcining occurs at 1200°C and uses alkali salts.

Companies and locations. Pharmaceutical plants, sugar refineries (see "Lime"), breweries and other beverage manufacturers use diatomite or other filter media.

Sources and suppliers. There are no diatomite mines within 400 kilometres of New Brunswick; the closest mines are located in British Columbia (Quesnel), California, Nevada, Oregon, and Washington.

FIGURE 1

CONSUMPTION OF DIATOMITE IN THE UNITED STATES, IN 1986 (D2)



Specifications. Diatomite is marketed in three grades - natural, calcined or pink, and flux-calcined or white. Although mining is by open-pit methods and normally uncomplicated, present processing techniques are not simple. For example, common size reduction methods such as ball milling or grinding would destroy the delicate structure of the mineral which would render it useless for such applications as filtration and as a flatting agent in paint. Current production techniques require costly plant equipment such as dryers, kilns, cyclones and air classifiers to produce a product of high purity and consistent uniformity. (D1)

Prices. Presented below are the average annual values for diatomite in the United States. (D2)

Category	Year (Cdn$ per tonne) 1984	1985	1986
Fillers	$257.00	$270.00	$323.00
Filtration	309.00	324.00	322.00
Insulation	201.00	163.00	191.00
Other	177.00	174.00	171.00

Substitutes. Expanded perlite, asbestos, and silica are displacing diatomite for pharamceutical and sugar processing filtering.

3.2 Fillers

Description. Diatomite is commonly used as a filler or extender for:

paints as a flatting agent (reduces paint glass)

paper as a bulking agent (increases thickness and density of paper)

concrete as a pozzolonic agent (acts with lime to produce cement)

plastics as a shrinkage-control agent (acts as a dimensionally-stable filler).

Companies and locations. The names and locations of filler consumers are presented as follows:

paints in Table 1

paper in "Sulphur" (Volume 1; Tables 6 and 7) and "Salt" (Volume 3; Tables 4 and 5).

concrete in "Cement and Cement Products" (Volume 2; Table 8)

plastics in Table 2

Sources and suppliers. See "Filtering".

Specifications. See "Filtering".

Prices. See "Filtering".

Substitutes. Mica, clay, and ground talc are displacing diatomite from the filler and extender markets, in particular as flatting agents in paint and fillers for paper.

TABLE 1

MAJOR PAINT MANUFACTURERS WITHIN 400 KILOMETRES OF NEW BRUNSWICK (D3, TRADE DIRECTORIES)

Province/State	Company	Location	Size	Products/Types of Paints
New Brunswick	Laurentide Chemicals Atlantic	Richibucto	01	Paints, coatings
	Norlantic Paint (Maritimes) Ltd.	Moncton	01	Highway paint
Newfoundland	The Standard Manufacturing Co. Ltd., Matchless Paints	St. John's	02	Paints, coatings
Nova Scotia	Tibbetts Paints Ltd.	Trenton	01	Paints, coatings
Quebec	Cartier Chemicals Ltd.	Quebec	N/A	Acid-alkali resistant, cement, chlorinated rubber, corrosion resistant, damp resisting, waterproofing
	Chemor Inc.	Montreal	01	Acid-alkali resistant, anti-corrosive, cement, coal tar, damp resisting, oil proof, resin emulsion, synthetic latex, texture, waterproofing
	Denalt Paints Ltd.	Montreal	N/A	Paint bases, aluminum, acid-alkali resistant anti-corrosive, bituminous, cement, chlorinated rubber, coal tar, corrosion resistant, damp resisting, general, heat resistant, mildew resistant, oil proof resin emulsion, street marking, strucural, synthetic latex, texture, waterproofing.
	Laurentide Chemicals	Shawinigan	N/A	Aluminum, anti-corrosive, cement, chlorinated rubber, coal tar, corrosion resistant, damp resisting dipping for rusted metal surfaces, heat resistant, metallic, resin emulsion, street marking, structural synthetic latex

Diatomite

TABLE 1 (continued)

Province/State	Company	Location	Size	Products/Types of Paints
Quebec (continued)	Polycol Ltd.	Point Claire	N/A	Resin emulsion
	West Chemical Products of Canada Ltd.	Ville d'Anjou	N/A	Paint booth compounds
New Hampshire	Fletchers Paintworks	Milford	02	Architectural paints and stains
Massachusetts	Cabot Samuel Inc.	Boston	03	Paint, stains and wood preservatives
	Eastern Lacquer Corp.	Malden	03	Paints, lacquers, enamels and specification finishes
	Hancock Paint & Varanish Company	Norwell	02	Paints and varnishes, architectural coatings, metal coatings
	Kyanize Paints Inc.	Everett	04	Paints, varnishes and enamels
	Lilly Industrial Coatings Inc.	Templeton	03	Lacquers, enamels, varnishes, stains, finishes, etc.
	Norfolk Corporation	Quincy	02	Paints
	Raffi and Swanson Inc.	Wilmington	03	Coatings, adhesives, synthetic resins, and resin emulsions
	Sterling-Clark-Lurton Corp.	Malden	02	Paint sundries, sealants, coatings
	Surface Coatings Inc.	Wilmington	03	Coatings, adhesives, synthetic resins, and resin emulsions
	Whittaker Coatings & Chemicals	Chicopee	02	Industrial paints and lacquers

N/A - not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

TABLE 2

MAJOR PLASTICS MANUFACTURERS WITHIN 400 KILOMETRES OF NEW BRUNSWICK
(TRADE DIRECTORIES)

Province/State	Company	Location	Size	Products/Types of Plastics
Quebec	BASF Canada Inc.	St.-Laurent	04	Chemicals, dye stuffs, recording tapes
	B.F. Goodrich Canada Inc.	Shawinigan	04	Polyvinyl chloride resins, compounds, additives, etc.
	CIBA-Geigy Canada Ltd.	Dorval	04	Pharmaceuticals, dyes, pigments, plastics, additives, etc.
	Compagnie Borden Ltee.	Laval	03	Resins and adhesives
	Cyanamid Canada Inc.	St.-Jean	04	Laminated decorative plastics, textile and paper resins, melamine component panels
	DuPont Canada Inc.	Montreal	N/A	Chemicals, nylon acrylic, polyester and spandex fibres, woven plastics, etc.
	M&R Plasics Inc.	Fabreville	02	Rigid plastic packaging material (design and processing), polyester resins
	Monsanto Canada Inc.	LaSalle	04	Plastics, plasticizers, organic chemicals, ABS, rubber curing agents, maleic anhydride chemical additives for pulp and paper, herbicides.
	Produits Chemiques Carlew Ltee.	St.-Remi-de-Napierville	02	Plastic and elastomeric compounds, plasticizers, PVC rigid, film and sheet
	Reichhold Limited	Ste-Therese	03	Synthetic resins

Diatomite

TABLE 2 (continued)

Province/State	Company	Location	Size	Products/Types of Plastics
Quebec (cont'd)	Union Carbide Du Canada Ltee	Pointe-Aux-Trembles	04	Petroleum based chemicals, polyethylene resins, antifreeze
Maine	Cyro Industries	Sanford	04	Acrylic sheet, acrylic molding and extrusion compounds, acrylic and polycarbonate double skinned sheet
	Gates Formed-Fibre Products Inc.	Auburn	03	Molded fibre products
New Hampshire	Nylon Corporation of America	Manchester	02	Nylon resins
Vermont	Whiting E.B. & A.C. Company	Burlington	03	Natural and synthetic brush and boom fibres
Massachusetts	Adams Plastics Co. Inc.	Holyoke	04	Molded plastics, Pakkawood, alaminated wood and products
	Bemis Associates Inc.	Watertown	02	Thermoplastic adhesive films and coatings
	Borden Chemical Co.	North Andover	04	Packaging films, PVC and oriented polypropylene
	Bostik Division	Middleton	04	Industrial adhesives, hot metal packaging, converting adhesives and applicator systems, shoe-making adhesives
	Can Pak Service Inc.	Longmeadow	03	Foams, ethafoam, polystyrene and polyurethane
	Carl Gordon Industries (Hammond Plastics Div.)	Worcester	02	Plastics materials, synthetic resins and nonvulcanizable elastomers

Diatomite

TABLE 2 (continued)

Province/State	Company	Location	Size	Products/Types of Plastics
Massachusetts (cont'd)	Cyro Industries	Sanford	04	Acrylic sheet, acrylic molding and extrusion compounds, acrylic and polycarbonate double skinned sheet.
	Decorative Products Division (National Gypsum Company)	Hatfield	04	Fabric backed vinyl wall covering and pressure sensitive decorator vinyl
	Devcon Corp.	Danvers	03	Filled epoxy and single adhesive compounds, etc.
	Eastern Cellophane Co. Inc.	Boston	02	Plastic materials, converters, cellophane and polyethylene bags, etc.
	Emerson & Cumming Inc.	Canton	04	Plastics and ceramics for electronics-microwave-absorbers and shielded testing chambers
	Gary Chemical Corp.	Leominster	03	Production of PVC (polyvinyl chloride compounds)
	Gates Formed-Fibre Products Inc.	Auburn	03	Molded fibre products
	General Electric Co. (Plastics Group)	Pittsfield	N/A	Valox thermoplastic polyester resin, lexan polycarbonate resin, etc.
	Hammond Plastics Division	Worcester	04	Plastics materials, synthetic resins and non-vulcanizable elastomers
	Key Polymer Corp.	Lawrence	02	Coatings and abrasives
	Lilly Industrial Coatings Inc.	Templeton	03	Lacquers, enamels, varnishes, stains, finishes, fillers, polyesters and polyurethanes

Diatomite

TABLE 2 (continued)

Province/State	Company	Location	Size	Products/Types of Plastics
Massachusetts (cont'd)	Lushan Herbert Plastics Inc.	Newton	03	Plastic materials, calender extruder injection mold, etc.
	Major Chemical & Latex Corp.	Boston	03	Natural and synthetic latex compounds, industrial adhesives, etc.
	Marson Corporation	Chelsea	04	Autobody fillers, epoxy and polyester compounds, silicon lubricants, fibreglass repair products, etc.
	New England Tape Co.	Hudson	02	Custom plastic extrusions, organosis and plasticols, custom fabrication of plastics
	Nylon Corporation of America	Manchester	02	Nylon resins
	Polysar Incorporated (Resins Div.)	Leominster	03	Polystyrene
	Polystyrene Business Group	Holyoke	02	Polystyrene
	Mobil Chemical Co. - Petrochemicals			
	Reichhold Chemicals Inc. (Vinyl Compounds Div.)	Mansfield	03	Plastics materials, synthetic resins and nonvulcanizable elastomers
	Sheffield Plastics Inc.	Sheffield	03	Plastic extrusion and extrusion, extruded polycarbonate fabrication, and acrylic sheet
	Surface Coatings Inc.	Wilmington	04	Coatings, adhesives, inks, synthetic resins, and resin emulsions

Diatomite

TABLE 2 (continued)

Province/State	Company	Location	Size	Products/Types of Plastics
Massachusetts (cont'd)	Talleyrand Chemicals Inc.	New Bedford	02	Polyvinyl chloride resins, exports and domestic
	Vernon Plastics Co. (Div. of Borden Chemical)	Haverhill	04	Plastic film and sheeting, printed and laminated plastic fabrics
	Whiting E.B. and A.C. Company	Burlington	03	Natural and synthetic brush and boom fibres

N/A - not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

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FELDSPAR

F E L D S P A R

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FELDSPAR

1.0 INTRODUCTION

Definition. Feldspars are a mineral group of anyhydrous aluminum silicates combined with one or more bases. Usually one base predominates and characterizes the feldspar, thus there are potash feldspars (microcline or orthoclase containing 10 percent or more potash (K_2O)), soda feldspars (albite, containing 7 percent or more soda (Na_2O)) and lime feldspars (anorthite containing calcined lime (CaO)). (Fd 1)

Chemical formulae are:

potash	$(K_2O.Al_2O_3.6SiO_2)$
soda	$(Na_2O.Al_2O_3.6SiO_2)$
lime	$(Na_2O.Al_2O_3.6SiO_2)$

Feldspars are very common minerals being found in large proportions in most igneous rocks.

Special properties. Feldspar has the following properties:

a) it is a good flux material for glass and ceramic production;

b) it is a good source of alumina for glass production; and

c) it is an inert mineral suitable as filler for paint, rubber and plastics. (Fd 1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Investigations of seven weathered granite occurrences as potential sources of feldspar have been conducted. (Fd 4) Exploration and development are not actively being considered at present.

3.0 CONSUMPTION

Use and quantities. In 1986, 2248 tonnes of feldspar were consumed in Canada of which 92 percent (2067 tonnes) were used in the production of ceramics. (Fd 2)

In the United States in 1986, 0.668 M tonnes of feldspar were sold or used by producers with 54 percent consumed for glass production and 46 percent for ceramics (see Table 1). (Fd 3)

3.1 Glass Production

Description. Feldspar is used in glass production as a source of alumina and alkali. Alumina enhances the workability of molten glass. It also increases the chemical stability of glass and inhibits devitrification. With increased workability glass can be more readily formed and shaped into jars and bottles. Increased chemical stability broadens the range of fluids which can be contained in glass.

Typically one tonne of glass requires 75-100 kilograms of feldspar.

Companies and locations. The names, locations and sizes of large glass manufacturers within 800 kilometres of New Brunswick are presented in Table 2.

Sources and suppliers. There are no producers of feldspar in Canada at present. There is only one feldspar producer in the United States within 800 kilometres of New Brunswick:

The Feldspar Corp., Middletown, Ct - soda feldspar

TABLE 1

FELDSPAR SOLD OR USED BY PRODUCERS
IN THE UNITED STATES, 1986 (Fd 3)

Type	Use	Quantity	
		Tonnes (M)	%
Hand-cobbed	pottery	0.010	1.5
	other	0.001	0.2
Flotation concentrate	glass	0.201	30.1
	pottery	0.273	40.7
Feldspar-silica mixtures (feldspar content)	glass	0.160	24.1
	pottery	0.023	3.5
Total	glass	0.361	54.2
	pottery	0.306	45.6
	other	0.001	0.2
Total		0.668	100.0

TABLE 2

GLASS MANUFACTURERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(Fd 5)

Province/State	Location	Owner	Glass Type	Notes
New Brunswick	Scoudouc	Domglas Inc.	containers	sand supplied by Indusmin
Quebec	Montreal	Domglas Inc.	containers	sand supplied by Indusmin
	Montreal	Consumers Packaging Inc.	containers	--
	Candiac	Consumers Packaging Inc.	containers	--
Ontario	Owen Sound	PPG Canada Inc.	flat	
	Scarborough	Ford Glass Limited	flat	for automobiles
	Brampton	Domglas Inc.	containers	sand supplied by Indusmin
	Hamilton	Domglas Inc.	containers	sand supplied by Indusmin
	Toronto	Consumers Packaging Inc.	containers	
	Milton	Consumers Packaging Inc.	containers	
Massachusetts	Milford	Foster-Forbes Glass Co., Division National Can Corp.	containers	
Connecticut	Dayville	Container General Corp.	containers	

reidspar

TABLE 2 (continued)

Province/State	Location	Owner	Glass Type	Notes
New York	Monroe Co.	Owens-Illinois Inc. Glass Container Div.	containers	
	Chemung Co.	Thatcher Glass Manufacturing	containers	
New Jersey	Vineland, Cumberland Co.	Owens-Illinois Inc., Kimball Div.	containers	
	Vineland, Cumberland Co.	Cumber-Wheaton Glass Co., a Div. of Wheaton Industries	containers	
	Salem, Salem Co.	Anchor Glass Container Hocking Corp.	containers	
	Bridgeton, Cumberland Co.	Kontes Glass Co.	containers	
Pennsylvania	Connellsville	Anchor Hocking Corp., Plant 5	containers	
	Montgomery Co.	Bohem Manufacturing Co.	flat	
	Brockway	Brockway Inc.	containers	
	Clarion Co.	Glass Container Corp., Parker Div.	containers	

TABLE 2 (continued)

Province/State	Location	Owner	Glass Type	Notes
Pennsylvania (continued)				
	Allegheny Co.	Glenshaw Glass Co., Inc.	containers	
	Cumberland Co.	Pennsylvania Glass Products Co.	containers	
	McKean Co.	Pierce Glass Co.	containers	
	Armstrong Co.	PPG Industries, Glass Div.	flat	
	Crawford Co.	PPG Industries, Works No. 8	flat	
	Clarion Co.	Owens-Illinois Inc. Glass Container Div.	containers	
	Luzerne Co.	Owens-Illinois Inc., Kimble Div.	containers	

Summary Statement for Table 5

Canada: Flat glass produced by 2 companies.
Glass containers produced by 8 companies.

United States: Flat glass produced by 3 companies.
Glass containers produced by 16 companies.

There are several feldspar mines in North Carolina and California.

Specifications. All feldspars consist of a mixture of potassium, sodium, and calcium aluminum silicate. The most desirable feldspars are those rich in potassium (potash feldspar) and sodium (soda feldspar).

For glass production the desired specifications are (Fd 1):

size: 20 to 40 mesh
content: 4-6% K_2O
5-7% NaO
19% Al_2O_3
0.05% (or less) Fe_2O_3 for clear glass
0.3% (or less) Fe_2O_3 for coloured glass

Prices. In 1986 the average value of imported feldspar was $160 per tonne in Canada. For the United States, glass-grade feldspar averaged $48-$73 per tonne. Prices for specific grades of feldspar are presented in Table 3.

Substitutes. The two main substitutes for feldspar in glass-making and ceramics are aplite and nepheline syenite. The latter is widely substituted for feldspar in Canada. Talc pyrophyllite, slags, lithospar, and Cornwall stone are other substitutes.

3.2 Ceramics

Description. In ceramics, feldspar is used as a flux. At a temperature below the melting point of most ceramics ingredients, feldspar fuses with those ingredients, bringing them into the physical and chemical reactions necessary for ceramics production. As well, feldspar acts as a vitreous binder, cementing the various crystalline ingredients in the ceramic.

TABLE 3

FELDSPAR PRICES (CDN $/TONNE) IN NORTH AMERICA, 1985-1987 (Fd 2)

Type	Price		
	1985	1986 ($/tonne)	1987
Ceramic grade, bulk	65.00	65.00	65.00
f.o.b. Spruce Pine, NC, 170-250 mesh			
f.o.b. Monticello, GA, 200 mesh, high potash	108.00	108.00	108.00
f.o.b. Middleton, CT, 200 mesh	78.00	78.00	78.00
Glass grade, bulk			
f.o.b. Spruce Pine, NC, 97.8% + 200 mesh	43.00	45.00	45.00
f.o.b. Middleton, CT, 96% + 200 mesh	57.00	57.00	57.00
f.o.b. Monticello, GA, 92% + 200 mesh, high potash	79.00	79.00	79.00

Companies and locations. Large manufacturers of ceramic tiles, pottery, and ceramic bathroom and kitchen ware are presented in Table 4.

Sources and suppliers. See section 3.1.

Specifications. Pottery-grade feldspar used for whiteware, requires 200 mesh or finer with 5-14 percent K_2O and a low Fe_2O_3 content (generally below 0.025 percent FeO_3). A high potash-to-soda ratio is preferred. For porcelain enamel, the preferred size is 120 to 140 mesh with no traces of garnet, hornblende, tourmaline, biotite mica tolerated. Glazing requires potash or soda feldspar ground fewer than 200 mesh.

Prices.

Prices for ceramic-grade feldspar in Canada are not available. In 1986, United States ceramic-grade feldspar was valued at $73 Cdn per tonne. Prices for specific grades of feldspar are presented in Table 3.

Substitutes. See Section 3.1.

TABLE 4

CERAMIC PRODUCERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(TRADE DIRECTORIES)

Province/State	Company	Location	Size*	Notes
Quebec	Ceramacor Inc.	Montreal	02	Ceiling modules, landscape planters, wall shield and floor protector systems for wood stoves
	Ceramiques Royal Ltee.	St-Leonard	01	Ceramic and marble tiles (wall and floor)
	Ceratec Inc.	Quebec	02	Ceramic floor and wall tile, bathroom fixtures
	Olympia Floor and Wall Tile Co.	Montreal	03	Ceramic wall tile
	Maple Leaf Ceramic Industries (1967) Ltd.	St-Laurent	03	Ceramic wall tile
	Gore Lamp & Shade Company Limited	Montreal	01	Boudoir, table, floor, desk and wall pin-up lamps, novelty and children's lamps, swag lamps, lampshades, decorated tile accessories
	Polyker Inc.	Dollard-Des-Ormeaux	01	Ceramic tiles
	Polyker Inc.	Gentilly	02	Quarry tile
Ontario	Durie Mosaic & Marble (1978) Ltd.	Ottawa	01	Terrazzo, finished marble tile, desco
	Norcros Industries Ltd.	Hamilton	02	Ceramic glazed wall tile
	Thunderbrick Limited	Thunder Bay	02	Face brick, quarry tile

*Size code at end of table.

TABLE 4 (continued)

Province/State	Company	Location	Size	Notes
Maine	Jane B. Scholz	Rockland	01	Stoneware, tiles
Massachusetts	Ceramics Grinding Co. Inc.	Waltham	01	Ceramics
	Screencraft Products Inc.	Yarmouth	01	Products hand screened ceramic tiles, general job screening
Rhode Island	Rosenthal Technik	Providence	04	Technical ceramic products
Connecticut	Haly Inc.	Brookfield	01	Industrial ceramic specialties
	Intercontinental Ceramics Corp.	Stamford	01	Ceramic wall floor tile
New York	Alcamo Marble Works Inc.	New York	01	Marble for floors and table tops, etc.
	American Olean Tile Co. Inc. (Sub. of National Gypsum Co.)	Olean	01	Ceramic mosaic floor and wall tile
	GAF Corp., Building Materials & Floor Products Groups	New York	04	Asphalt mineral fiber building and floor maintenance materials
	Jackson Export Co., Inc., Modern Art Linens	Yonkers	02	Shower curtains, towels, plastic and ceramic accessories, porcelain accessories
	Paragon Supply Inc.	Syracuse	N/A	Building blocks, face and fire brick, ceramic glazed structural tile
	Tam Ceramics Inc.	Niagara Falls	04	Titanium and zirconium products
	Weatherguard/Marblelaid Products Inc.	Bronx	01	Composition floors

TABLE 4 (continued)

Province/State	Company	Location	Size	Notes
New Jersey	Frenchtown American Corp.	Frenchtown	03	Ceramics-to-metal seal assemblies and materials
	GAF Corp., Building Materials Group	Wayne	01	Manufacture residential and commercial roofing products
	Kane Carpet Co.	Secaucus	03	Tiles
	Mannington Mills Inc.	Salem	04	Floor coverings, ceramic tile
	Wenczel Tile Co.	Trenton	04	Ceramic tile
Pennsylvania	American Olean Tile Co.	Lansdale	01	Glazed and unglazed ceramic floor and wall tile
	American Olean Tile Co.	Quakertown	01	Ceramic floor and wall tile
	Dal-Tile Corp., Dal-Keystone Div.	Gettysburg	N/A	Cermaic tile
	Design-Technics Ceramics Inc.	Pen Argyl	01	Ceramic wall surfacing, ceramic lamps and accessories
	Glass Beads Co.	Latrobe	01	Glass and hybarlox preforms, paste, pressed alumina ceramics, metallized plated brazed ceramics.
	Hanley Brick Inc.	Summerville	04	Brick, tile, glazed and unglazed paving tile, structural glazed facing tile and chemical brick, face brick common brick
	O.W. Ketcham Inc.	Philadelphia	N/A	Brick and clay tile
	MCE Inc.	East Butler	N/A	Metallizing ceramics and hermetic seals

TABLE 4 (continued)

N/A - Not Available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

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FLUORSPAR

FLUORSPAR

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FLUORSPAR

1.0 INTRODUCTION

Definition. Fluorspar is the commercial name for the mineral fluorite. Chemically known as calcium fluoride, it has the formula (CaF_2). Pure fluorspar usually contains 51.1 percent calcium and 48.9 percent fluorine. (F1)

Special properties. Properties that make crystalline fluorspar useful in optical systems such as prisms and as components of high-quality, special-purpose lenses include:

- a very low index of refraction;
- low dispersion;
- it is isotropic; and
- its ability to transmit ultraviolet light.

Other important properties are its high melting point (1378°C) and its very low solubility in water. (F3)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

The mineral fluorite occurs at over 35 locations in the Province (F4) but is not being actively evaluated for production.

3.0 CONSUMPTION

Uses and quantities. Fluorspar is produced in three principle grades--acid, ceramic and metallurgical.

Acid-grade fluorspar (acidspar) generally contains at least 97 percent calcium fluoride and is generally used as a feedstock in the manufacture of hydrofluoric acid. The chemical and aluminum industries account for a large percentage of hydrofluoric acid consumption. Fluorcarbons which are produced by reacting hydrofluoric acid with carbon tetrachloride or chloroform, are used in the manufacture of solvents, resins, plastics, films, refrigerants and aerosol propellants.

Ceramic-grade fluorospar is marketed in various grades. The most common are No. 1 ceramic which contains 95 percent to 96 percent calcium fluoride and No. 2 ceramic which contains 85 percent to 90 percent calcium fluoride. The ceramic industry uses fluorspar for the production of flint glass, white or opal glasses and enamels. Other uses include the fabrication of welding rods, as a flux in making steel, and as an abrasive on certain types of sandpapers.

Metallurgical-grade flurospar (metspar) can contain a minimum of 60 percent effective calcium fluoride to a maximum of 85 percent calcium fluoride. However, the term "metspar" is sometimes used for material containing as high as 96 percent calcium fluoride. Metspar is used primarily by the iron and steel industry in welding fluxes and welding rod coatings. (F3)

consumption data on fluorspar for Canada is presented in Table 1 and consumption data for the United States is presented in Table 2.

TABLE 1

CONSUMPTION OF FLUORSPAR IN CANADA,
1983 AND 1984[1] (F1)

Use	1983 tonnes (thousands)	1983 %	1984 tonnes (thousands)	1984 %
Metallurgical flux	17.1	10.5	14.4	8.2
Foundries	10.5	6.4	9.6	5.4
Other[2]	135.8	83.1	152.8	86.4
Total	163.4	100.0	176.8	100.0

1 Consumption, as reported by known consumers

2 Includes consumption in the production of aluminum, chemicals, petroleum refining and other miscellaneous uses.

TABLE 2

CONSUMPTION OF FLUORSPAR IN THE UNITED STATES, 1986 (F2)

Use	Containing Greater Than 97% Calcium Fluoride	Containing Less Than or Equal to 97% Calcium Fluoride	Total	
	tonnes	tonnes	tonnes	%
Hydrofluoric acid (HF)	381 981.8	—	381 981.8	72.6
Glass and fiberglass	1 118.2	815.5	1 933.7	0.4
Enamel and pottery	W	2 089.1	2 089.1	0.4
Welding rod coatings	8 272.7	1 980.0	10 252.7	1.9
Primary aluminum and magnesium	W	—	—	—
Iron and steel castings	—	5 297.3	5 297.3	1.0
Open-hearth furnaces	W	20 480.0	20 480.0	3.9
Basic oxygen furnaces	W	64 458.2	64 458.2	12.2
Electric furnaces	1 141.8	26 473.6	27 615.4	5.3
Other	11 460.9	646.4	12 107.3	2.3
Total	403 975.4	122 240.1	526 215.5	100.0

W - withheld, included with other

Description. In Canada, other uses accounted for 83.1 percent of the consumption of fluorspar in 1983 and 86.4 percent in 1984. In the United States hydrofluoric acid accounted for 72.6 percent of the consumption of fluorspar in 1985.

The importance of metallurgical-grade fluorspar in the steel industry is its ability to remove impurities (sulphur and phosphorus, in particular) during melting and to improve separation of metal and slag in the furnace by making the slag more fluid. Applications of fluorspar in the ceramic industry allows it to act as a flux and as an opacifier. (F1)

Suppliers and sources. There is one main producer of fluorspar in Canada, St. Lawrence Fluorspar Ltd. (owned by Minworth Ltd. of England) in St. Lawrence, Newfoundland.

In the United States, flurospar was produced by one major producer and three small producers in 1984. Ozark-Mahoning Co., the major producer operated three mines and a floatation plant in Pope and Hardin Counties, Illinois. (F2)

Specifications. Generally for acid-grade fluorspar moisture content of the dried material is preferably 0.1 percent or less. To control the rate of chemical reaction and stack losses, particle size and distribution are sometimes specified.

Specifications on impurities vary for ceramic-grade fluorspar as shipments of ceramic-spar are generally altered to the specific needs of consumers.

Metspar used as gravel must pass a 1 to 1½ inch screen and contain less than 15 percent of material passing a 1/16 inch screen. (F3)

Prices. Presented in Table 3 are prices per tonne of domestic and imported fluorspar for the United States for 1985. These prices were unchanged from those of 1984. Figures were not available for Canada.

Substitutes. There are only a few materials that may act as a substitute for fluorspar. Dolomite and massive manganese slag may act as a substitute for fluorspar in the steel industry. However, dolomite tends to build up in the vessels and massive manganese slag is not readily available in large volumes. (F3)

TABLE 3

FLUORSPAR PRICES (IN CANADIAN DOLLARS)*
PER TONNE OF DOMESTIC AND IMPORTED FLUORSPAR (F2)

	1985
Domestic, f.o.b. Illinois-Kentucky:	
Metallurgical: 70% effective CaF_2 briquets	183.30
Ceramic, variable calcite and silica:	
88% to 90% CaF_2	146.70
95% to 96% CaF_2	249.30
97% CaF_2	242.00-256.70
Acid, dry bais, 97% CaF_2:	
Carloads	253.70
88% effective CaF_2 briquets	262.50
European and South African[1]: acid, term contracts	205.30-264.00
Mexican:[2]	
70% effective CaF_2, f.o.b. vessel, Tampico	117.40
70% effective CaF_2, f.o.b. cars, Mexican border	110.90
Acid, bulk: 97+%, Mexican border	158.90

*$1 Cdn = $0.75 US

1 C.i.f. east coast, Great lakes, and Gulf ports

2 U.S. import duty, insurance, and freight not included

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GRAPHITE

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GRAPHITE

1.0 INTRODUCTION

Definition. Graphite, like coal and diamond, is a naturally occurring form of carbon. It is a soft (1 to 2 on the Mohs' Hardness Scale), lustrous, black mineral typically forming hexagonal crystals. Its specific gravity is 2.266. (Gr 1)

Special properties. The special properties of graphite include:

1) excellent conductivity of electricity;
2) excellent conductivity of heat;
3) high melting temperature (3000°C);
4) extreme resistance to acid;
5) chemical inertness;
6) highly refractive;
7) softness; and
8) blackness. (Gr 1)

Graphite can also be produced synthetically. Table 1 presents a list of synthetic graphite producers within 400 kilometres of New Brunswick. For this report, however, only the production and consumption of natural graphite will be described in detail.

TABLE 1

MAJOR PRODUCERS OF SYNTHETIC GRAPHITE
WITHIN 400 KILOMETRES OF NEW BRUNSWICK (Gr 2, Gr 3)

Province/State	Company	Location	Product [1]
Maine	Fiber Materials Inc.	Biddeford	Cloth and high-modulus fibers
Massachusetts	Avco Corp., Avco Specialty Materials Div.	Lowell	High-modulus fibers
	The Stackpole Corp., Carbon Div.	Lowell	High-modulus fibers, motor brushes, unmachined shapes, refractories, powder

---

1 Cloth includes low-modulus fibers; electric motor brushes include machined shapes; crucibles include vessels.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Deposits of natural graphite were reportedly worked in the Split Rock and Marble Cove areas near Saint John in the 1840s. In more recent years a deposit at Golden Grove, east of Saint John, has been evaluated by Glenvet Resources Ltd. Possible reserves in excess of 22 500 tonnes are estimated. Metallurgical testing suggests potential as a source of flake graphite. (Gr 5)

Other occurrences are also known in various regions of the Province, but are not being actively explored.

3.0 CONSUMPTION

Use and quantities. Canadian graphite consumption (Gr 1) in 1985 consisted of:

foundry facing	5404 tonnes	(45.0%)
metallurgical	4802 tonnes	(40.0%)
refractories	472 tonnes	(3.9%)
other	1335 tonnes	(11.1%)

See Figure 1.

In 1986 graphite consumption in the United States followed the pattern of Table 2 (Gr 2) with major uses being:

refractories	25.3%
lubricants	14.7%
foundries	14.1%
brake linings	12.9%

3.1 Refractories and Crucibles

Description. Graphite has very high-temperature properties. Its strength increases with temperature, it has high thermal conductivity, low thermal expansion, and good chemical resistance. (Gr 1)

Companies and locations. See Silica (Volume 2).

Sources and suppliers. Most refractory graphite would be supplied by mining companies or producers of synthetic graphite. There is one graphite mine within 800 kilometres of New Brunswick (Asbury mine in western Quebec). Producers of synthetic graphite within 400 kilometres of New Brunswick are presented in Table 1.

Specifications. Flake graphite is used in the manufacture of crucibles for the steel, nonferrous and precious metals industries. It is preferred to microcrystalline graphite

FIGURE 1

CANADIAN CONSUMPTION OF
GRAPHITE BY USE, IN 1985
(GR1)

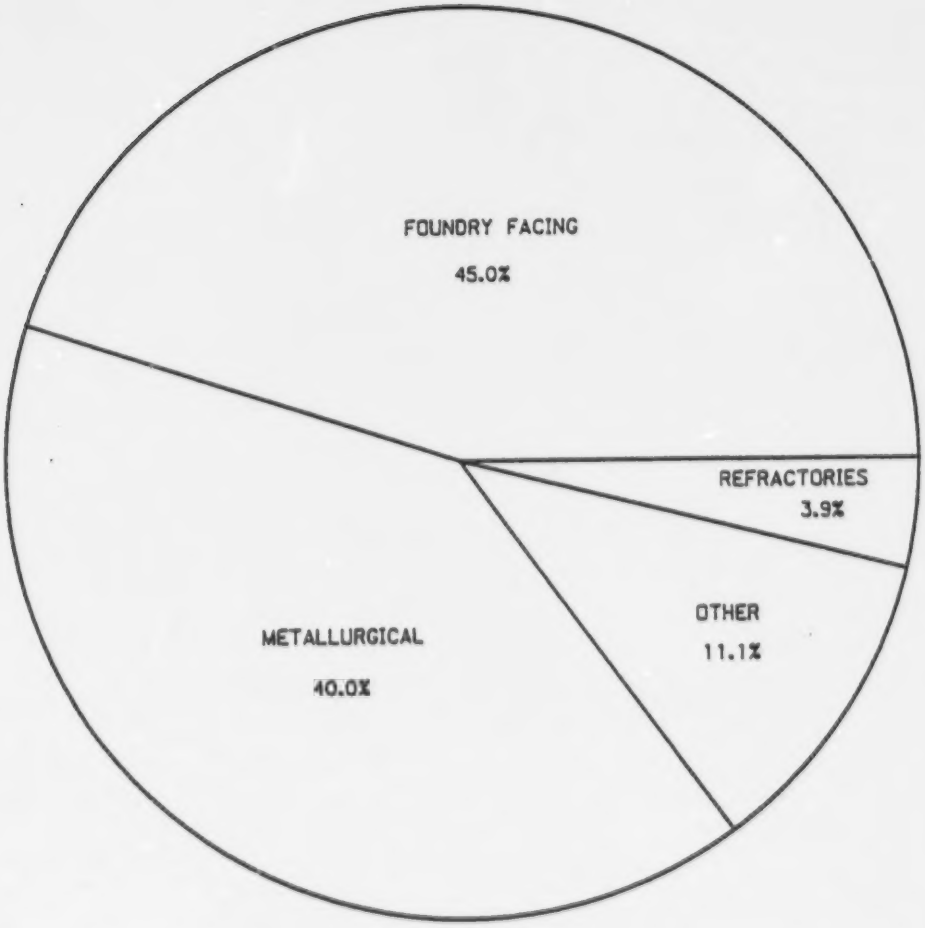

TABLE 2

UNITED STATES CONSUMPTION OF NATURAL GRAPHITE, 1986 (Gr 2)

Use	Crystalline (Tonnes)	Amorphous (Tonnes)	Total (Tonnes)	%
Batteries	W	W	1 418	4.9
Brake linings	1 321	2 393	3 714	12.9
Carbon products (bearings and brushes)	369	192	561	1.9
Crucibles, retorts, stoppers, sleeves and nozzles	1 378	13	1 391	4.8
Foundries	503	3 560	4 063	14.1
Lubricants	756	3 476	4 233	14.7
Pencils	1 582	260	1 842	6.4
Powdered metals	417	101	518	1.8
Refractories	W	W	7 291	25.3
Rubber	201	141	342	1.2
Steelmaking	119	1 405	1 524	5.3
Other	85	1 863	1 948	6.8
Withheld uses (see W above)	6 143	2 566	-	-
TOTAL	12 875	15 971	28 845	100.0

because it burns more slowly, has a high attrition resistance and imparts structural strength through the orientation of the flakes. For this application, graphite must be of large flake size, above 300 microns, with a carbon content of 90 percent, although finer flake size with a carbon content in the range of 80 to 90 percent is also used.

In ramming mixes, graphite imparts high refractoriness, low thermal expansion and high resistance at elevated temperature. Microcrystalline graphite of high purity, 80 to 95 percent carbon is required.

Carbon refractories are classified as including more than 7 percent carbon in a blend with either microcrystalline or flake graphite, and are known as magnesia carbon brick. Mag-Carbon brick is used in high temperature and corrosion prone applications such as in steel furnace lining, ladles, slag-lines, hotpots, nozzles and blast furnace. Graphite is used because of its thermal conductivity, and thermal and chemical resistance. Flake graphite must have a carbon content between 90 and 97 percent and sizes ranging from 75 to 180 microns. Amorphous graphite is also used with carbon content of around 70 and 80 percent and size larger than 600 microns. Size of flakes is important but not as critical as the degree of compaction of the bricks and shapes. Porosity needs to be minimal.

Prices. Prices for various types and grades of graphite are given in Table 3.

Substitutes. There is considerable substitution for graphite concentrates allowing consumers to demand high quality from producers. For example, vein graphite is susceptible to substitution by high purity, lower cost crystalline flake graphite. (Gr 1, Gr 4)

TABLE 3

GRAPHITE PRICES ($CDN PER TONNE)

Source	Year	Type/Grade	Price
United States Bureau of Mines and Minerals (f.o.b. mine)	1986	Flake and crystalline in bags	
		China	97 - 2750
		West Germany	727 - 5210
		Madagascar	518 - 1780
		Sri Lanka	485 - 2425
		Amorphous, nonflake, microcrystalline graphite (80-85% carbon)	
		South Korea (bags)	145 - 195
		Mexico (bulk)	145 - 200
Industrial Minerals (cif U.K. port)	1986	Crystalline lump 92-99%C	735 - 1465
		Crystalline large flake 85-90%C	840 - 1335
		Crystalline medium flake, 85-90%C	655 - 1145
		Crystalline small flake 80-95%C	400 - 1065
		Powder (200 mesh)	
		80-85%C	335 - 365
		90-92%C	545 - 615
		95-97%C	735 - 1000
		97-99%C	1000 - 1335
		Amorphous, powder, 80-85%	235 - 465
Chemical Marketing Reporter (f.o.b. mine bags)	1986	Crystalline, powder	
		88-90%C	880 - 1760
		90-92%C	1180 - 2060
		95-96%C	1760 - 2640
		97%C and up	2340 - 3520
		Flake	
		No. 1 90-95%C	1900 - 2200
		No. 2 90-95%C	1900 - 2200
		Amorphous, powder	470 - 1170
		Powder 97% and up	2350 - 3520
	July, 1988	Amorphous, powder	470 - 1170
		Crystalline powder, 88-90%C	880 - 1760
		Crystalline powder, 90-92%C	1180 - 2200

TABLE 3 (continued)

Source	Year	Type/Grade	Price
		Crystalline powder, 95-96%C	1760 - 2640
		Amorphous/crystalline 97% and up	2340 - 3520
		Flake, No. 1 and No. 2 90-95%C	1910 - 2200

3.2 Lubricants

Description. The properties of softness, low friction, inertness, and heat resistance make graphite an excellent industrial lubricant. (Gr 1)

Companies and locations. Graphite lubricants are used for a wide variety of industrial machines.

Sources and suppliers. See Table 1.

Specifications. Lubricating graphite should have a particle size below one micron and a carbon content between 96 and 99 percent. Crystalline graphite is preferred. (Gr 1, Gr 4)

Prices. See Table 3.

Substitutes. There are many industrial lubricants which can be substituted for graphite. New developments and improvements could enhance the applicability of graphite or one of its competitors.

3.3 Foundry

Description. Graphite is used as a mould coating to prevent the adhesion of metal to the mould and as a recarburizer to increase carbon content of high iron content melts - such as those rich in scrap.

Sources and suppliers. See Table 1.

Specifications. For coating, amorphous dust (lump or micro-crystalline) is used with a grain size between 53 and 75 microns. Carbon content sholud be 40-70 percent. A wide range of graphite types can be used for recarburizing. (Gr 1, Gr 4)

Prices. See Table 3.

Substitutes. For recarburizing synthetic graphite and coke can be used.

3.4 Brake Linings

Description. Wear rate is reduced with graphite in brake linings as graphite's softness and good thermal properties are used as an advantage. (Gr 1)

Companies and locations. Manufacturers of brake linings within 800 kilometres of New Brunswick are listed in Table 4.

Sources and suppliers. Graphite for brake linings would come from any of the producers of crystalline graphite.

Specifications. Fine crystalline graphite of size below 75 microns is used. The carbon content is usually specified as greater than 98 percent; however, concentrations as low as 90 percent are acceptable if the concentration of abrasive impurities (silica) is low.

Prices. See Table 3.

Substitutes. Asbestos and other high-temperature effective materials are also used for brake linings.

TABLE 4

LARGE MANUFACTURERS OF BRAKE LININGS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(TRADE DIRECTORIES)

Province/State	Company	Location	Size
Ontario	Abex Industries Limited, Friction Products Division	Lindsay	03
	Certified Brakes - Lear Siegler	Mississauga	02
	Hemisphere International	Downsview	02
Massachusetts	Auto Friction Corp.	Lawrence	02
Pennsylvania	Carlisle Corp., Molded Materials Div.	Ridgway	04

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

4.0 BIBLIOGRAPHY (GRAPHITE)

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Gr 3 "Chemical Suppliers." Process Industries Canada, November 1986, pp. 3-68.

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KAOLIN

KAOLIN

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KAOLIN

1.0 INTRODUCTION

Definition. Kaolin is a white clay comprised of the minerals kaolinite, hallysite, dickite. It is formed by weathering of igneous rocks. It has a fusion point of 1785°C and a specific gravity of 2.6. (K1)

Special Properties. Kaolin has the following properties which make it a very useful industrial mineral; it is:

1. chemically inert over a wide pH range;
2. white;
3. a good hiding and covering material as a pigment or extender;
4. soft;
5. nonabrasive;
6. a poor conductor of heat;
7. a poor conductor of electricity; and
8. low cost. (K1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Kaolin clays have not been commercially produced in the Province. The material is a component of the deposit currently operated for silica production by Sussex Silica Inc., located at Cassidy Lake, near Sussex. Their screening and washing operation separates the very fine fractions and routes them to a settling pond. A significant component of this reject material is kaolin but fine silica and other material is also present. A method of separating the kaolin would have to be evaluated. As well, product quality and market interest are major factors in assessment of the potential for production.

3.0 CONSUMPTION

Use and quantities. In 1985 the reported consumptions of china clay (kaolin) in Canada were:

pulp and paper products	0.165 tonnes (M)	78.6%
ceramic products	0.009 tonnes (M)	4.5%
rubber and linoleum	0.008 tonnes (M)	3.8%
paint and varnish	0.006 tonnes (M)	3.0%
other products	0.021 tonnes (M)	10.0%

See Figure 1.

Almost all of the kaolin used in Canada is imported from the United States, mainly Georgia. (K2)

Consumption for the United States in 1986 is presented in Table 1. The leading uses (K3) were:

paper coating (domestic)	27.1%
paper filling (domestic)	15.7%
paper coating (export)	9.4%
brick, common and face (domestic)	7.6%
grogs and calcines, refractory (calcine)	4.6%
fibreglass, mineral wool and other insulation	4.3%
rubber	3.4%

3.1 Paper Coating

Description. Kaolin is a very important coating pigment in the paper industry. Good quality kaolin smooths the paper surface, produces a paper surface which is even and uniformly absorbent for printing and improves the appearance of the paper.

FIGURE 1

CONSUMPTION OF CHINA CLAY (KAOLIN)
IN CANADA, 1985 (K2)

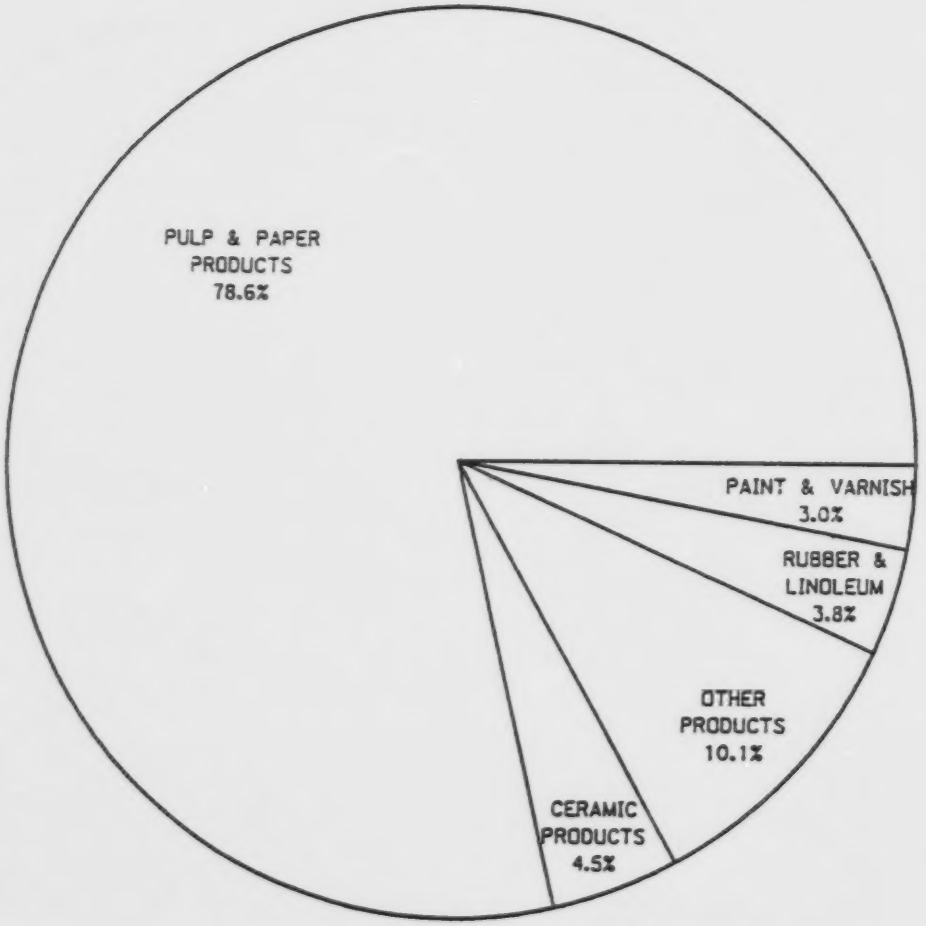

TABLE 1

KAOLIN SOLD OR USED
BY PRODUCERS IN THE UNITED STATES (1986) (K3)

Use	Quantity tonnes (M)	%
DOMESTIC		
Adhesives	0.064	0.8
Aluminum sulfate and other chemicals	0.141	1.8
Animal feed	0.034	0.4
Brick, common and face	0.593	7.6
Catalysts (oil and gas refining)	0.113	1.5
Cement, portland	0.186	2.4
China and dinnerware	0.022	0.3
Crockery and other earthenware	W	NA
Electrical porcelain	0.019	0.2
Fertilizers	0.004	**
Fibreglass, mineral wool and other insulation	0.334	4.3
Firebrick, blocks and shapes	0.063	0.8
Floor and wall tile ceramic glazes, glass, enamels	0.028	0.4
Flue linings, high-alumina brick and specialties	0.081	1.2
Foundry sand	*	
Grogs and calcines, refractory	0.356	4.6
Gypsum products and wallboard	0.017	0.2
Ink	W	NA
Kiln furniture, refractory and mortar cement	0.053	0.7
Linoleum and asphalt tile	0.016	0.2
Medical, pharmaceutical, cosmetic	0.003	**
Paint	0.228	2.9
Paper coating	2.105	27.1
Paper filling	1.219	15.7
Pesticides and related products	0.019	0.2
Plastics	0.046	0.6
Pottery	0.033	0.4
Roofing granules	0.025	0.3
Roofing and structural tile	*	**
Rubber	0.262	3.4
Sanitary ware	0.135	1.7
Waterproofing and sealing	W	NA
Miscellaneous	0.234	3.0
Subtotal	6.434	82.8
EXPORTS		
Ceramics	0.017	0.02
Foundry sand, grogs and calcines, other refractories	0.194	2.5
Paint	0.107	1.4
Paper coating	0.731	9.4
Paper filling	0.207	2.7
Plastics	*	**
Rubber	0.047	0.6
Miscellaneous	0.035	0.5
Subtotal	1.338	17.2
TOTAL	7.772	100.0

* less than 0.001 tonnes (M)
** less than 0.1%
W withheld
NA not available

A good coating must possess all or most of these properties:

a) good dispersability in water;
b) correct particle size distribution;
c) high opacifying power;
d) low abrasion;
e) low chemical reactivity;
f) high brightness;
g) low water absorption;
h) low demand for adhesives; and
i) compatibility with other paper ingredients.

Kaolin possesses most of these properties and is especially favoured with good body and finish properties. While the proportions may vary, some papers contain up to 35 percent clay as a coater and filler. (K4)

Companies and locations. Table 2 presents information on all the coated paper mills within 400 kilometres of New Brunswick. Almost all of these mills use kaolin shipped from the southern United States.

Sources and Suppliers. Almost all the kaolin used in Canada for pulp and paper coating comes from the United States. In turn, 99.9 percent of the coating kaolin produced in the United States comes from Georgia.* Major suppliers of Georgia kaolin are:

Anglo-American Clays Corp., Atlanta
Cyprus Industrial Minerals Co., Clay Div., Sandersville
Georgia Kaolin Co., Millidgevile
Huber Corp., J.M., Clay Div., Macon
Thiele Kaolin Co., Sandersville

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*In 1986 Georgia produced 2.103 tonnes (M), the United States 2.105 tonnes (M)

TABLE 2

COATED PAPER MILLS WITHIN 400 KILOMETRES OF NEW BRUNSWICK
(K5)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Notes
New Brunswick	Edmundston	Fraser Inc.	100	A few products, coating equipment - on machine
	Newcastle	Miramichi Pulp & Paper Inc.	600	A few products, coating equipment - off machine
Quebec	Jonquiere	Cascades (Jonquiere) Inc.	160	Many different kinds of paper, coating equipment - on machine, mill closed in 1983.
	Trois Rivieres	Kruger Inc., Newsprint Div.	680	A few products, coating equipment - off machine
Maine	Rumford	Boise Cascade Corp.	1 290	Many products, coating equipment - on machine
	Bucksport	Champion International	1 000	A few products, coating equipment - on machine, - off machine
	Brewer	Eastern Fine Paper, Inc. (Div. of Eddy Paper Co. Ltd.)	165	Many products, coating equipment - off machine
	Madawaska	Fraser Paper Ltd.	765	Many products, coating equipment - on machine, off machine

TABLE 2 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Notes
Maine (cont'd)	Millinocket	Great Northern Paper Co.	1 280	A few products, coating equipment - on machine, off machine
	Jay	International Paper Co.	1 230	A few products, coating equipment - on machine
	Jay	James River - Otis Div.	125	A few products, coating equipment - on machine, off machine
	Hinckley	Scott Paper Co.	545	A few products, coating equipment - off machine
	Westbrook	S.D. Warren Co.	N/A	A few products, coating equipment - on machine, off machine
Vermont	Sheldon Springs	Boise Cascade Corp.	135	Many different kinds of paper, coating equipment - on machine
	North Bennington	Vermont Tissue Paper Corp.	10	Products include coated specialty tissue
Massachusetts	East Walpole	Hollingsworth & Vose Co.	45	A few different kinds of paper.
	West Springfield	Premoid Corp.	30	May different kinds of paper. Coating equipment 2 60" reverse roll

Specifications. Kaolin specifications are based upon the method of preparation and physical and chemical properties. Water washed kaolin is preferred to air separated kaolin as it is brighter and less abrasive and has better size distribution. Grit (silica) mica, and ferric oxide are undesirable impurities. (K4)

Prices. In late 1986 the following prices were quoted for paper-grade kaolin (K3):

Water-washed, fully calcined, bags, carload lots, f.o.b. Georgia	$ 374/tonne
Paper-grade, uncalcined, bulk carload lots, f.o.b. Georgia	
No. 1 coating	$ 138/tonne
No. 2 coating	110/tonne
No. 3 coating	107/tonne
No. 4 coating	103/tonne

Substitutes. Precipitated calcium carbonate, titanium oxide, satin white ($3\ CaO.Al_2O_3.3\ CaSO_4.31\ H_2O$), zinc pigments (zinc oxide, zinc sulfide, lithopane), barium sulfate, calcium sulfite, calcium sulfate, and diatomite are other coatings used for paper. Each offers special or improved properties to those of kaolin but most are too expensive to threaten significantly kaolin's share of the coating market. (K4)

3.2 Paper Fillers

Description. Fillers are essential for producing many types of papers. They improve the properties of paper by:

a) increasing opacity;
b) increasing brightness;
c) increasing smoothness;
d) improving finish;
e) improving receptivity to ink;
f) increasing density;
g) improving absorbency; and
h) improving appearance.

To be a good filler, a mineral must have the following properties:

1. a high degree of whiteness;
2. a high refraction index;
3. low solubility;
4. small particle size;
5. low specific gravity;
6. inertness to most chemicals; and
7. low price.

Kaolin has all the above properties except the high refraction index. (K4)

Presented in Table 3 are the types and amounts of fillers used for different grades of paper.

TABLE 3

TYPE AND AMOUNT OF FILLER USED IN DIFFERENT GRADES OF PAPER (K4)

Paper Grade	Filler Type	Quantity of Filler Added, % (by Weight)
Bond and writing	High-opacity pigment plus clay	1 - 6
Book	Clay plus high-opacity pigment	5 - 40
Offset paper	Clay plus high-opacity pigment	0 - 10
Bible paper	Clay and chalk plus high-opacity pigment	20 - 30
Cigarette paper	Fine chalk	35 - 40
Mimeograph	Clay and diatomaceous silica plus high opacity pigment	20 - 25
Envelope	Talc or clay plus high-opacity pigment	10 - 20
Newsprint	Clay or calcium carbonate	2 - 6

Companies and locations. Presented in Table 4 is information on all the plants within 400 kilometres of New Brunswick which produce filler grade papers.

Substitutes. Other than kaolin, common fillers are:

titanium dioxide (high opacity and brightness, expensive)

calcium carbonate (higher brightness than kaolin, high oil absorption, more reactive than kaolin)

calcium silicate (improves bulk, opacity, and brightness)

talc (gives soapy feel to paper, improves sheet formation)

Other than calcium carbonate, none could displace kaolin from other than specialty products. (K4)

Trends. European paper producers use an alkaline process which favours calcium carbonate over kaolin as a filler and extender. The alkaline process is projected to make significant inroads in the North American market in the next 10-15 yeras. If so, calcium carbonate consumption would grow at the expense of kaolin. (K1)

Product development by kaolin producers has resulted in fine-grained calcined material which is replacing more expensive titanium dioxide. (K1)

TABLE 4

PAPER PLANTS WITHIN 400 KILOMETRES OF NEW BRUNSWICK
WHICH PRODUCE FILLER-GRADE PAPERS (K5)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
New Brunswick	Dalhousie	NBIP Forest Products is jointly owned by CIP Inc., Oji Paper Co. Ltd., and Mitsui & Co. Ltd.	1 050	Newsprint
	Saint John	Rothesay Paper Ltd., subsidiary of Irving Pulp & Paper Ltd.	932	Newsprint
Newfoundland	Grand Falls	Abitibi-Price Inc., Grand Falls Div.	680	Newsprint
	Stephenville	Abitibi-Price Inc., Stephenville Div.	450	Newsprint
	Corner Brook	Corner Brook Pulp and Paper, subsidiary of Kruger Inc.	745	Newsprint
	Port Hawkesbury	Stora Forest Industries, Div. of Stora Kopparberg, Falun, Sweden.	500	Newsprint

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Quebec	Shawinigan	Consolidated-Bathurst Inc., Belgo Div.	920	Newsprint, Offset paper
	Trois Rivieres	Consolidated-Bathurst Inc., Wayagamack Div.	480	Various products including envelopes
	Ville de la Baie	Consolidated-Bathurst Inc., Port Alfred Div.	1 020	Newsprint
	Gatineau	CIP Inc., Gatineau Mill (Sub. of Canadian Pacific Enterprises Ltd.)	1 300	Newsprint
	Beauharnois	Domtar Inc., Fine Papers Div.	55	Fine papers, including bond, writing, envelope and cigarette
	Dolbeau	Domtar Inc., Newsprint & Kraft Pulp Div.	430	Newsprint
	Donnacona	Domtar Inc., Newsprint & Kraft Pulp Div.	500	Offset paper
	Windsor	Domtar Inc., Fine Papers Div.	550	Fine papers including writing, envelope, mimeo-graph and offset paper
	Clermont	Donohue Inc.	740	Newsprint
	Amos	Donohue Normick Ltd.	470	Newsprint

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Quebec (Cont'd)	Hull	Eddy Forest Products Ltd., E.B.	260	Various products including bond, envelope, mimeograph, offset paper, writing paper
	Chandler	Gaspesia Pulp & Paper Co. Ltd.	630	Newsprint
	Bromptonville	Kruger Inc., Newsprint Div.	800	Newsprint
	Trois Rivieres	Kruger Inc., Newsprint Div.	680	Newsprint and a few other products
	Alma	Price Co. Ltd.	620	Newsprint
	Baie Comeau	Quebec and Ontario Paper Co. Ltd.	1 230	Newsprint
	Quebec	Reed Paper Ltd.	1 150	Newsprint Pulp board
	Mont Rolland	Rolland Inc.	70	Various fine papers including bond, envelope and writing paper
	Saint Jerome	Rolland Inc.	360	Various fine papers including bond, envelope, mimeograph, offset paper and writing paper

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Quebec (cont'd)	Riviere-Du-Loup	F.F. Soucy Inc., Sub. of the Bato Co. Inc.	450	Newsprint
	Saint Raymond	St. Raymond Paper Ltd.	160	Newsprint and a few other products
Maine	Rumford	Boise Cascade Corp., Paper Group, Rumford Mill	1 230	Bond, envelope, writing paper and other products
	Brewer	Eastern Fine Paper, Inc. (Div. of Eddy Paper Co. Ltd.)	165	Various fine papers including bond, mimeograph and offset paper
	Madawaska	Fraser Paper Ltd., Sub. of Fraser Inc.	1 105	Various products including including Bible, bond, mimeograph, offset paper and writing paper
	Woodland	Georgia- Pacific Corp.	250	Bond, offset paper and a few other products
	East Millinocket	Great Northern Paper Co. Div. of Great Northern Nekoosa Corp.	830	Newsprint
	Jay	International Paper Co.	1 250	Bond, envelope, offset paper, and a few other products

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Maine (cont'd)	Jay	James River-Otis Inc., Sub. of James River Corp.	120	Bond and a few other products
	Lincoln	Lincoln Pulp & Paper Co. Inc., Sub. of Preco Corp.	315	Bond, mimeograph, offset paper, writing paper and and a few other products
	Brunswick	Pejepscot Paper, Div. of the Hearst Corp.	150	Offset paper and other products
Vermont	East Ryegate	CPM Inc.	55	Envelope and many other products
	Gilman	Georgia-Pacific Corp., Whitefield Paper Div.	180	Envelope, offset paper, writing paper and many other products
Massachusetts	Dalton	Byron Weston Co., Div. of Crane & Co. Inc.	45	Bond, envelope, offset paper, writing paper and many other products
	Dalton	Crane & Co. Inc., Bay State Mill	20	Bond, writing paper and other products
	Dalton	Crane & Co. Inc., Pioneer Mill	20	Bond and a few other products
	Turners Falls	Esleeck Manufacturing Co. Inc.	not available	Bond, writing paper, and other products
	Fitchburg	Fitchburg Paper Co., owned by Techno Graphics	200	Envelope, offset paper, and many other products

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Massachusetts (cont'd)	Adams	James River Corp., Curtis Div., Adams Plant	20	Bond, mimeograph, offset paper, writing paper, and many other products
	Hyde Park	James River Corp., Groveton Group, Hyde Park Mill	180	Bond, mimeograph, offset paper and other products
	East Pepperell	James River-Pepperell Inc., Sub. of James River Corp.	270	Envelope and many other products
	Lee	Kimberly-Clark Corp., Lee Mills	80	Bible and a few other products
	Holyoke	Linweave Fine Papers Inc.	90	Mimeograph, offset paper, writing paper and other products
	Lawrence	Merrimac Paper Co. Inc.	75	Envelope and many other products
	Holyoke	Nu-Valley Paper Co.	45	Bond, envelope, writing paper and other products
	Holyoke	Parsons Paper, Div. of NVF Co.	25	Writing paper and many other products
	Housatonic	Rising Paper Co.	55	Bond, writing paper and many other products

TABLE 4 (continued)

Province/State	Location	Owner	Total Paper/ Board Capacity (tonnes/day)	Products
Massachusetts (continued)	West Springfield	Southworth Co.	15	Bond, envelope and other products
	Millers Falls	Strathmore Paper Co., Div. of Hammermill Paper Co.	25	Bond and writing paper, and a few other products
	Turners Falls	Strathmore Paper Co. Div. of Hammermill Paper Co.	Not available	Bond, writing paper and a few other products
	Westfield	Strathmore Paper Co., Div. of Hammermill Paper Co.	80	Bond, writing paper and many other products
	Woronocco	Strathmore Paper Co., Div. of Hammermill Paper Co.	Not available	Bond, writing paper and other products

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LIMESTONE
DOLOMITE
LIME

L I M E S T O N E/D O L O M I T E/L I M E

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LIMESTONE/DOLOMITE/LIME

1.0 INTRODUCTION

Definition. Limestone is a sedimentary rock composed primarily of the mineral calcite ($CaCO_3$). Dolomite, (or dolostone) is a sedimentary rock composed primarily of the mineral dolomite ($CaMg(CO_3)_2$). Several other components can also be present but generally are regarded as impurities that detract from the quality of a deposit. The term "carbonate" or "carbonate rock" is often used in a general sense to identify these rocks. The term "limestone" is also frequently used in a generic context to describe the material without regard to strict limits of chemical composition and the term "dolomitic limestone" is used when there is a high magnesium content. Marl is an unconsolidated material with a substantial carbonate content which is deposited in shallow lakes, etc., and is included in the generic limestone category.

The major uses of limestone are for aggregates (crushed stone), cement, lime production, chemical process stone, and pulverized stone. Aggregates are outside the scope of this report and are covered in other documents. Cement is discussed elsewhere in this report under "Cement and Cement Products."

Lime does not occur in nature, it is made by calcining a rock with a high calcium carbonate content. The primary raw material for lime is limestone; others are: marble, dolomite, chalk and by-product sludges. At the calcine temperature of 900°C, CO_2 dissociates from the $CaCO_3$ leaving CaO (quicklime). When quicklime is mixed with water it forms hydrate (hydrated calcium oxide), $CaOH_2$.

Agricultural lime is actually a finely crushed limestone that is not calcined. While this commodity is commonly referred to as "lime", the usage is incorrect and has been avoided here.

The composition of quicklime or hydrate is dependent upon the composition of the limestone (or other) source. Lime with less than 5 percent magnesium oxide and few impurities is a high calcium lime. If the magnesium oxide content is between 5 and 35 percent, the lime is a magnesium lime and if the magnesium oxide content exceeds 35 percent, it is a dolomitic lime. Typical analyses for quicklime produced in the United States are presented in Table 1. (L15)

For this report lime will be defined as either quicklime or hydrate.

TABLE 1

TYPICAL ANALYSES OF COMMERCIAL QUICKLIMES (L15)
(NATIONAL LIME ASSOCIATION)

Component	Range*	
	High Calcium	Dolomitic
CaO	93.25 - 98.00	55.50 - 57.50
MgO	0.30 - 2.50	37.50 - 40.80
SiO_2	0.20 - 1.50	0.10 - 1.50
Fe_2O_3	0.10 - 0.40	0.05 - 0.40
Al_2O_3	0.10 - 0.50	0.05 - 0.50
H_2O	0.10 - 0.90	0.10 - 0.90
CO_2	0.40 - I.50	0.40 - 1.50

*These are typical ranges, not minima and maxima percentages.

Special properties. Limestone has four important properties:

1) hardness;
2) durability;
3) alkalinity; and
4) source of calcium, carbon dioxide, and magnesium.

The first two properties make limestone a useful source for building and highway aggregates. Limestone's alkalinity makes it a popular "sweetener" for sour soils and sour gases. At high concentrations of calcium, limestone becomes an excellent raw material for the manufacture of quicklime and hydrated lime.

Lime (quicklime and hydrated lime) has seven valuable properties:

1) alkalinity;
2) affinity for water;
3) affinity for carbon dioxide;
4) affinity for silica;
5) source of calcium;
6) ability to form mortar and plaster; and
7) relatively low cost.

Lime's alkalinity is effective to neutralize acids in industrial processes. Quicklime readily absorbs water from the atmosphere making it a useful dessicant. Hydrate and quicklime react with carbon dioxide to form insoluble calcium carbonate effectively removing both carbon dioxide and lime from solution.

The affinity of lime by silica benefits both the smelting process (flux formation) and the glass industry.

Lime is the primary source of calcium for industrial and metallurgical purposes.

Limestone is a key material in the formation of cement and plaster.

Because of its relatively low cost, lime is one of the most widely and heavily used industrial chemicals (along with sulphuric acid).

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

The occurrence of limestone has been known in New Brunswick for over 350 years. Champlain saw and described its occurrence in the Saint John district in the early part of the 17th century. Little is known of early production, but it has been stated that Brouillon used Saint John lime in the rebuilding of the fort at Port Royal in 1701. Lime is reported to have been shipped to New England long before the American Revolution.

The industry grew slowly until in 1890 there were about 25 lime-burning units operating in the Saint John area; a thriving lime export trade had developed with the United States. This trade rapidly declined, however, with the introduction of the McKinley Bill which placed an import duty of 6 cents per hundred weight on lime entering the United States.

During the last century numerous lime kilns were active in nearly every county in the Province. Many of these kilns were primitive and supplied essentially local needs, but were gradually supplanted by larger kilns in Saint John from which lime was transported by boat and train.

In the early part of the present century, the Provincial Lime Policy was established under the Agricultural Assistance Act. This policy was initiated in order to increase the use of agricultural limestone in the Province. It provides for production subventions to approved suppliers and payments to defray transportation costs in shipping the stone from the plants to the farmers. (L19) A historical review of this policy shows the relationship of policy changes to limestone production.

To meet the demand related to this policy the Government of New Brunswick subsequently constructed an agricultural limestone plant in Brookville, Saint John County to supply all farmers located in areas serviced by railways. This plant was later purchased by the Brookville Manufacturing Company and is still in operation.

By 1930 the limestone industry was centered in Saint John with small producers located in northern and eastern New Brunswick. At that time, eight producers were quarrying limestone and four operators were manufacturing lime. In addition to lime, the products included agricultural limestone, stone for use in the pulp and sugar refining industries, poultry grit and crushed stone. One year earlier, at Saint John, the first hydrated lime was produced in the Province. (L19)

In 1952, Canada Cement Company Limited began production of cement at Havelock; the first such plant in the Maritimes. This plant used limestone from a nearby quarry, contributing significantly to the growth in total limestone production during the fifties.

Total limestone production tends to be somewhat irregular since the figures include both cement manufacture and crushed stone categories. Periodic short-term increases in demand by the construction industry strongly influence the demand for limestone in these categories. Table 2 provides a subdivided summary of recent limestone production in the Province. The lack of lime production in 1969-70 is a function of a fire which destroyed the Snowflake Lime operation in Saint John in 1968. Declining production for cement during the 1980s is a function of the phase-out of production at the Lafarge operation in Havelock.

TABLE 2*

SUMMARY OF LIMESTONE PRODUCTION (SHORT TONS) IN NEW BRUNSWICK (L19)

Year	Chemical Process Stone	Pulverized Stone	Crushed and Building Stone	Quick[1] & Hydrated Lime Manufacture	Cement[2] Manufacture	Limestone Total
1946	4,847	107,135	3,583	32,873	0	148,438
1947	5,320	100,363	6,522	31,407	0	143,612
1948	6,500	106,683	18,937	34,326	0	166,446
1949	4,032	94,748	26,184	34,623	0	159,587
1950	12,493	70,399	21,834	35,541	0	140,267
1951	7,624	95,364	39,960	31,431	0	174,379
1952	6,588	54,737	52,255	29,756	140,610	283,946
1953	7,939	54,401	67,163	31,776	191,763	353,042
1954	7,933	52,566	55,633	33,800	198,957	348,889
1955	7,273	52,391	364,026	28,292	203,111	655,093
1956	377	48,116	455,239	27,470	220,091	751,293
1957	766	53,893	443,242	27,648	217,641	743,200
1958	682	65,981	132,848	22,343	239,621	461,475
1959	598	72,761	65,821	27,347	27,155	393,682
1960	2,671	68,458	227,917	25,091	217,116	541,253
1961	7,957	83,538	255,279	20,730	227,368	594,872
1962	7,948	82,858	776,275	26,012	225,865	1,118,958
1963	5,268	110,567	639,009	25,379	215,238	995,461
1964	0	102,417	690,500	7,460	231,737	1,032,114
1965	5,848	110,042	250,500	5,331	235,748	607,469
1966	212,551(?)	135,517	(34,068)?	5,601	331,213	650,814
1967	5,260	103,815	242,925	4,323	305,993	662,316
1968	11,502	146,127	335,371	3,911	194,000[5]	691,004[4]
1969	30,275	139,190	131,535	0	245,000	546,000
1970	32,160	148,697	104,143	0	220,000	505,000
1971	73,038[3]	93,309	259,653	46,000[4]	183,000	655,000
1972	45,857	123,684	240,459	48,000	262,000	720,000
1973	57,304	150,397	367,299	60,000	312,000	947,000
1974	68,989	120,285	598,000[4]	70,000	242,000	1,099,000
1975	129,914	190,621	658,000	78,000	258,000	1,314,000
1976	79,356	218,639	498,000	87,000	382,000	1,265,000
1977	132,214	105,798	591,000	87,000	509,000	1,425,000
1978	121,000[4]	147,000[4]	481,000	100,000	393,000	1,242,000
1979	125,000	157,000	335,000	105,000	373,000	1,095,000
1980	99,000	157,000	688,000	90,000	286,000	1,320,000
1981	97,000	181,000	277,000	104,000	321,000	980,000
1982	98,000	176,000	257,000	100,000	234,000	865,000
1983	104,000	176,000	209,000	n/a	n/a	610,000
1984	n/a	182,000	n/a	120,000	n/a	610,000
1985	104,000	177,000	223,000	118,000	65,000	687,000

*continued on next page

TABLE 2 (continued)

1. Estimated by multiplying reported lime production by 1.5. A portion of reported lime is hydrated, thus this factor is used rather than the 1.78 theoretical factor for determining the amount of $CaCO_3$ required to yield 1 unit weight of CaO.

2. Estimated by multiplying reported cement production by 1.33, which is the approximate ratio of limestone used by Canadian cement plants to Canadian cement output.

3. Of which 39,127 short tons were shipped to foreign lime kilns.

4. Estimated to within 20% of actual and rounded to nearest 1000 for this and subsequent years.

5. Calculated for 1968-1982, using Statistics Canada value of cement production and cement selling price index. Calculated limestone quantity rounded to nearest 1000.

Table 3 presents the value of limestone production excluding that for cement and lime purposes. The value of lime production is shown in Table 4. The values in Table 4 do not directly correlate to Table 2 because of differences in units (short tons vs tonnes) and the conversion assumptions made in Table 2.

There are currently five producers of limestone in New Brunswick. Each is briefly summarized below (L20):

Brookville Manufacturing Company Ltd. at Brookville, East Saint John, is a producer of agricultural dolomitic limestone, fertilizer filler, roofing granules, concrete and asphalt aggregate, driveway aggregate, road metal and hardpack road subbase. Annual production is in the 200,000 to 225,000 tonne range. A decade ago, it ranged up to 500,000 tonnes. Crushing and milling (pulverizing) capacity are approximately 250 and 90 tonnes per hour, respectively, but are operated on only a sufficient number of days per year to meet projected demand. Figure 1 illustrates some of the components of the crushing operation.

Havelock Lime (a division of Dickenson Mines Ltd.) at Havelock produces calcitic agricultural lime, industrial and chemical process stone, and crushed stone for aggregate. An associated operation, (formerly known as Havelock Processing Ltd. but now part of Havelock Lime), is Atlantic Canada's only producer of calcined and hydrated lime. Annual quarry output and crusher feed is in the order of 300,000 tonnes. Crushing capacity is about 280 tonnes per hour and pulverizing capacity is about 45 tonnes per hour. Calcining capacity has been about 175 to 200 tonnes per day. A recently installed Fuller annular shaft kiln, the first of its kind in North America, will have a capacity of 300 tonnes per day. Traditionally the source of supply for the operation has been a quarry at Samphill but the current method of extraction is becoming limited by a high stripping ratio for

FIGURE 1

BROOKVILLE
AGGREGATE PLANT, (L20)

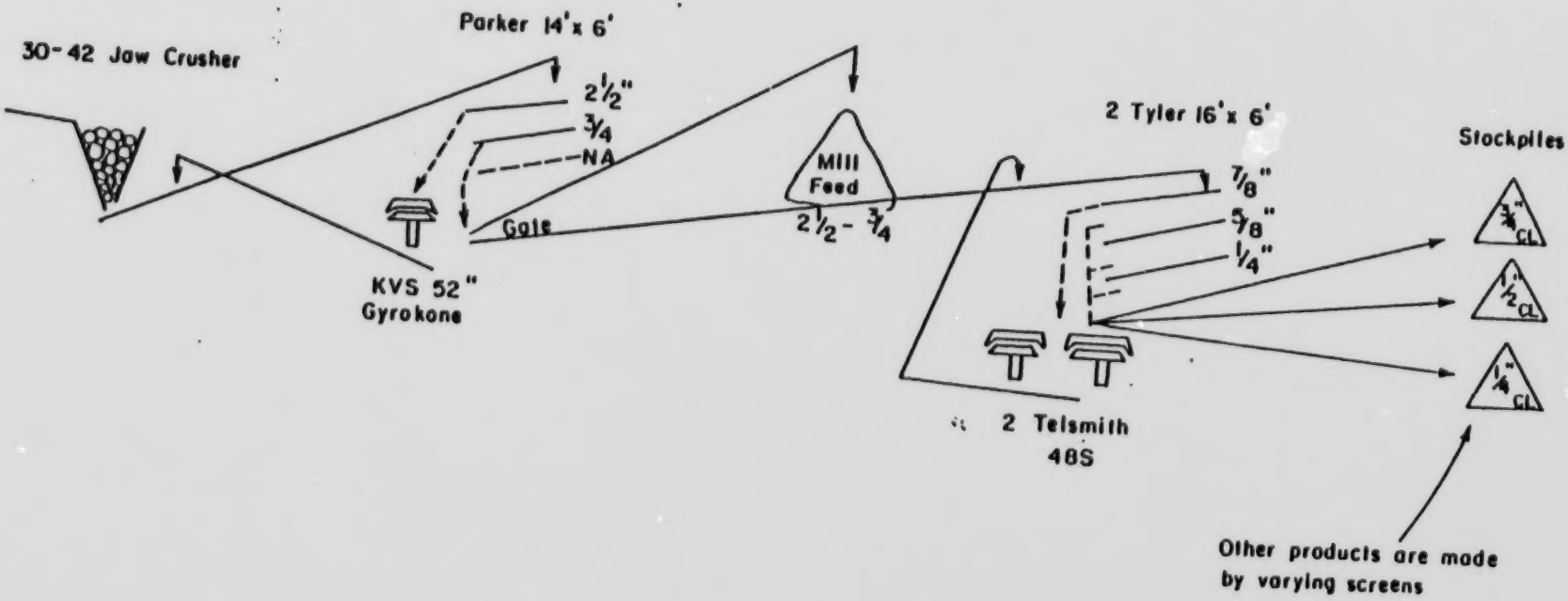


TABLE 3

VALUE OF LIMESTONE PRODUCTION (SHIPMENTS) IN NEW BRUNSWICK EXCLUDING STONE FOR PRODUCTION OF CEMENT AND LIME, BUT INCLUDING MARL, DOLOMITE AND MARBLE (L20)

Year	Current Dollars
1946	$ 283 301
1947	262 820
1948	335 519
1949	305 357
1950	289 422
1951	384 259
1952	337 988
1953	316 397
1954	299 038
1955	610 226
1956	655 575
1957	793 349
1958	503 278
1959	425 593
1960	495 981
1961	793 465
1962	939 619
1963	828 740
1964	877 402
1965	821 743
1966	1 019 000
1967	916 000
1968	1 040 000
1969	750 000
1970	912 000
1971	1 097 000
1972	1 121 000
1973	1 734 000
1974	2 004 000
1975	2 995 000
1976	3 289 000
1977	3 600 000
1978	3 651 000
1979	3 381 000
1980	5 040 000
1981	4 192 000
1982	4 585 000
1983	4 557 000

TABLE 4

NEW BRUNSWICK LIME PRODUCTION (L21, L22)
1946-1987

Year	Tonnes	Current Dollars	Constant 1987 Dollars
1946	19886	$ 286	$ 2 090
1947	E	E	
1948	E	E	
1949	E	E	
1950	E	E	
1951	19014	370	1 837
1952	E	E	
1953	E	E	
1954	E	E	
1955	E	E	
1956	16725	408	1 959
1957	E	E	
1958	16334	394	1 785
1959	16334	417	1 865
1960	15426	379	1 674
1961	15426	308	1 351
1962	15426	391	1 694
1963	15426	383	1 629
1964	4537	126	526
1965	3630	101	412
1966	3630	100	394
1967	2722	77	292
1968	2722	75	274
1969	0	0	0
1970	0	0	0
1971	E	194	637
1972	E	651	2 042
1973	E	995	2 789
1974	E	1 000	2 626
1975	E	1 303	3 088
1976	E	1 440	3 174
1977	E	2 137	4 364
1978	E	2 166	4 062
1979	E	1 905	3 273
1980	E	3 415	5 325
1981	E	2 935	4 069
1982	E	3 961	4 956
1983	E	4 080	4 828
1984	E	5 154	5 837
1985	E	5 340	5 821
1986	E	E	
1987	E	E	

E - data not available

"overburden". However, a long-term agreement has been arranged which ensures supply from a nearby quarry operated by Lafarge Canada Inc. Figures 2 and 3 illustrate some of the components of the Havelock Lime operation.

Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.) has a quarry and cement production facility adjacent to Highway 880 several kilometres east of Havelock. Cement production began at this site in 1952. However, the prominence of the plant as a Maritime producer has diminished since 1982. Since 1982, production of cement from the local raw material essentially has been limited to fulfilling market requirements for oil well and other specialty cements. In each of the 5 years preceding 1982 cement production totalled more than 300,000 tonnes. In addition, 40,000 to 250,000 tonnes of limestone are quarried annually for Havelock Lime Works Ltd. and additional amounts periodically for the Canfarge ready-mix division, Permanent Concrete. The Canada Cement Lafarge plant has a reported clinker production capacity of 300,000 tonnes per year and a grinding capacity of 315,000 tonnes. Crushing capacity is 450 tonnes per hour.

Elmtree Resources Ltd. operates a quarry and crushing-pulverizing plant about 20 km north of Bathurst near the Village of Petit Rocher, Gloucester County. Annual production of 50,000 to 60,000 tonnes is primarily sold to the lead smelter at Belledune as flux and, to a lesser extent, to other buyers as aggregate, fertilizer filler and agricultural limestone. Crushing and pulverizing capacity are sufficient to supply more than four times the current annual demand. Resources in the explored area of the present quarry are sufficient for several years at the current rate of production, but two other deposits recently evaluated appear to have inferred reserves sufficient for several decades at current production levels. Figure 4 outlines the process flow sheet at Elmtree.

FIGURE 2

HAVELOCK LIME WORKS LTD. FLOWSHEET FOR AGRICULTURAL AND INDUSTRIAL LIME PLANT, (L 20)

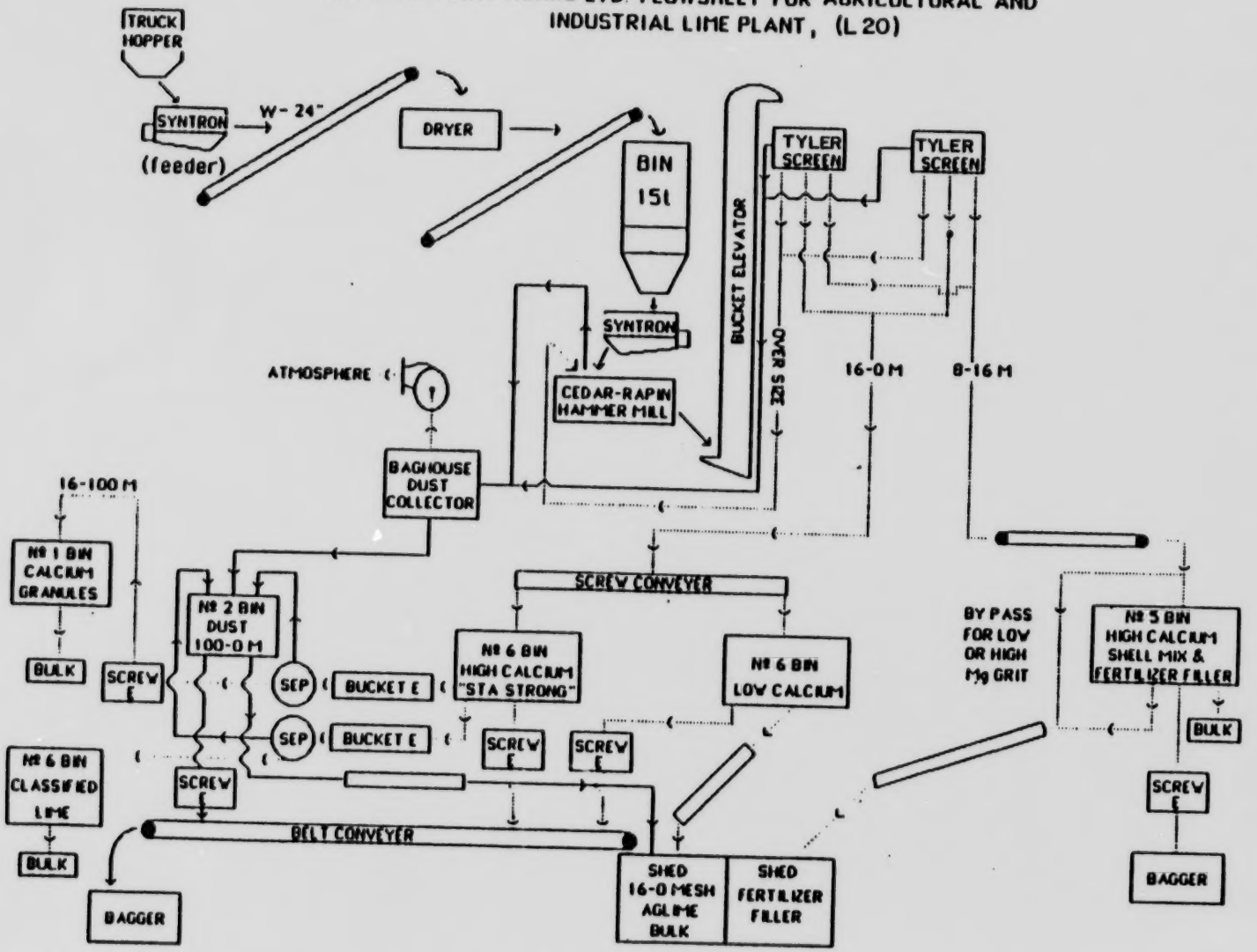
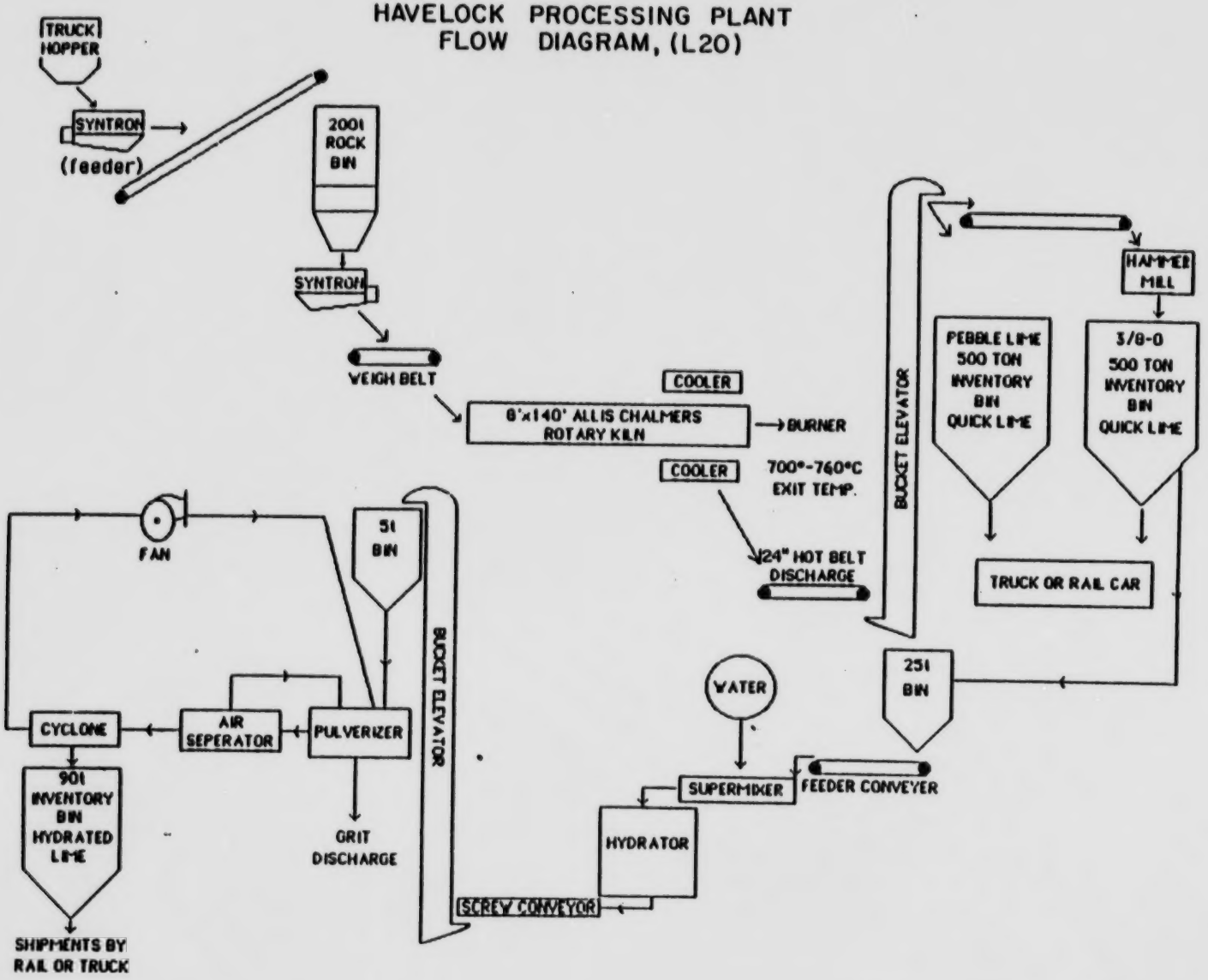
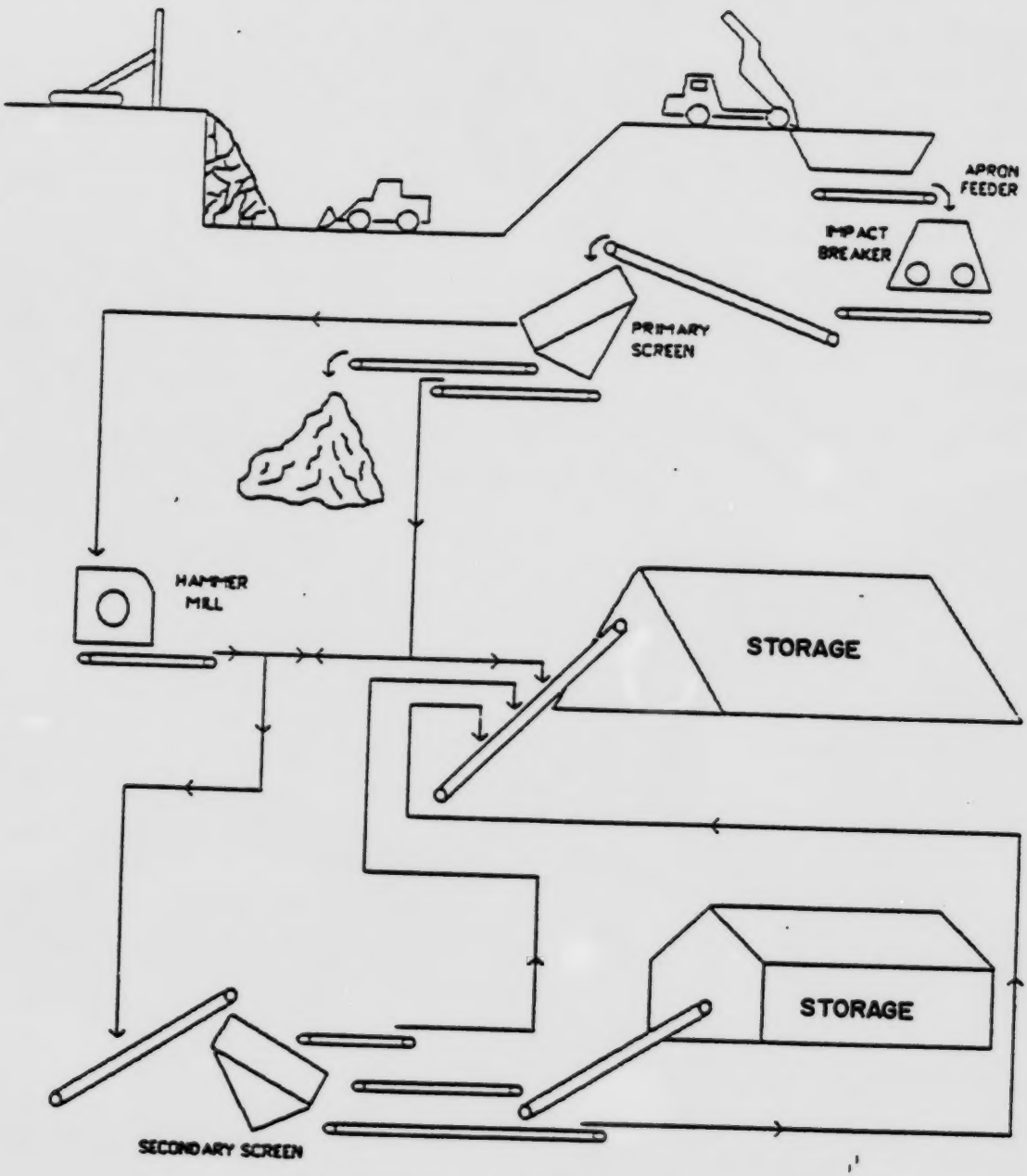


FIGURE 3

HAVELOCK PROCESSING PLANT
FLOW DIAGRAM, (L20)





ELMTREE RESOURCES FLOWSHEET, (L20)

FIGURE 4

Upper Kent Lime Ltd. is a producer of marl from the bed of a small drained lake (White Mud Lake) at Maplehurst near Upper Kent in Carleton County. Annual sales to the region's farmers are in the 1000 to 1500 tonne range.

In addition to these current producers, there are numerous other deposits of limestone/dolomite in the Province. Several of these areas are currently held under mineral claims and some are being actively evaluated.

In addition to the "traditional" uses of carbonate rocks which have been discussed here, a less common application has been recently evaluated. A recent announcement by Norsk Hydro has confirmed their intention to construct a plant at Becancour, Quebec to produce magnesium metal. The plant will use proprietary process technology to convert magnesium oxide to magnesium metal. The company has also considered the construction of plant to produce the magnesium oxide. Such a plant would require a high quality dolomite plus seawater for the process and, although some sites in New Brunswick, as well as Quebec and Newfoundland, meet these basic criteria, Norsk Hydro has apparently decided to import magnesium oxide from existing facilities.

Another potential source of magnesium is from the mineral carnallite ($KMgCl_3.6H_2O$). This mineral is known to occur in salt/potash deposits in southern New Brunswick, but is not currently produced.

3.0 CONSUMPTION

3.1 Limestone

Uses and quantities. The major uses of limestone are for aggregates (crushed stone), cement, lime production and agriculture. A use of growing importance is flue gas desulphurization.

Aggregates are outside the scope of this report; however, they are covered in other reports available through the Department of Natural Resources and Energy.

Cement is discussed in "Cement and Cement Products."

Agricultural limestone is a low value product with its market area restricted by transportation costs to a radius of 300-400 kilometres depending upon the availability of transportation subsidies. In 1987, 0.131 M tonnes of limestone was used in New Brunswick. The Province provides a transportation subsidy for agricultural limestone.

Limestone is used in several dry and wet flue gas scrubbing systems. The principle for both systems is to maximize the contact of the acid gases (SO_2 in particular) with the alkali (limestone or lime). In the dry system, limestone powder is added in the fluid bed firing system while in the wet system a limestone slurry meets sulphur exhaust gases in a special scrubber chamber. The waste product of this process is calcium sulphate (gypsum). (L4)

An interesting use of limestone is for the rehabilitation of lakes and streams affected by acid precipitation. Initial experiments with lime found the chemical too reactive, it produced pH changes which were almost or more damaging than the acid conditions. In addition, the effects were short-term.

Limestone reacts more slowly and lasts longer in the water system, mirroring natural buffering processes. The limestone is applied as a powder, from boats or on ice by vehicles.

Companies and locations. For flue-gas desulphurization the major consumers are the large electrical power utilities. For acid-rain control, the major consumers are the provincial and state departments of environment.

Sources and suppliers. Limestone is supplied by all the suppliers of dolomite and lime presented later in this chapter. In addition, limestone is available from many small aggregate operations. Thus, in many cases, a source of limestone is only a short distance away from the consumer and the market area for these producers is therefore small.

Specifications. Limestone specifications for aggregate uses were not within the scope of this study, but are documented in other reports available through the N.B. Department of Natural Resources and Energy.

Limestone for cement is discussed in "Cement and Cement Products."

For agricultural purposes grain size and chemical purity are key specifications. Limestone for feed should have a high calcium content with low levels of magnesium, iron, silica, and heavy metals. Grain size should be small (all below 5 mm, most below 3 mm) to allow animals to eat and digest the limestone and to aid in handling. (L4)

Limestone for land application has similar requirements. The content of calcium oxide or calcium oxide plus magnesium oxide is the key chemical variable as the applicator wishes to have maximum neutralizing properties. Fine grain size is important as small grains are easier to spread and have a high reaction rate. (L4)

For flue gas desulphurization, a finely ground, high purity (85-95 percent $CaCO_3$) limestone is required. Some iron aids the process but magnesium oxide causes problems and should be kept below 5 percent (the magnesium sulfate reaction product is quite soluble and difficult to dispose properly).

For lake and stream rehabilitation, a fine limestone high in calcium and low in heavy metals is preferred. The benefits are further enhanced by using a lime slurry. (L4, L17)

Prices. Limestone for chemical purposes is grouped with structural limestone in government statistics. In 1985 limestone was valued at $4.14 per tonne in New Brunswick. See Table 5 for prices for dolomitic limestone and aglime in New Brunswick in 1988. (L24)

Substitutes. For most of its uses limestone's only substitute is lime. However, the substitution is not significant because of the substantial difference in reactivity and cost between lime and limestone. Limestone's low cost and reactivity is preferred in most agricultural (feed, land application) uses and other applications to nature such as neutralizing acid lakes and streams.

In flue gas desulphurization either lime or limestone can be used, the choice depending upon process and cost factors. (L5)

3.2 Dolomite

Uses and quantities. In Canada and the United States dolomite statistics are covered with those for lime and limestone. Many lime applications are suitable for magnesium limestone or dolomite and are covered in Section 3.3 "Lime." However, there are two applications for which dolomite is preferred to high calcium lime: refractories (dead-burned dolomite) and as a raw materials source for magnesium production.

TABLE 5

PRICES FOR DOLOMITIC LIMESTONE AND AGLIME
IN NEW BRUNSWICK IN 1988 (L24)

Type	Prices/(tonne) Retail	Wholesale Under 3000 Tonnes	Wholesale Over 3000 Tonnes
A) Dolomitic limestone quarry rock			
Quarry run	$ 9.00	$ 7.30	$ 6.45
Loader select	10.50	8.95	7.90
Rip rap	10.40	8.85	7.65
Minus Products			
6" minus	$ 7.60	$ 6.55	$ 5.50
1-1/4" minus	7.25	6.20	5.15
3/4" minus	7.25	6.20	5.15
1/4" minus	7.25	6.20	5.15
Clear Products			
2-1/2" - 3/4"	$10.25	$ 8.40	$ 7.00
1-1/2" - 3/4"	10.25	8.40	7.00
7/8" - 1/4"	10.25	8.40	7.00
7/8" - 5/8" (3/4" CL.)	10.25	8.30	7.00
5/8" - 1/4" (1/2" CL.)	10.25	8.30	7.00
1/2" - 1/4" (3/8" CL.)	12.00	10.10	8.55
7/16" - 1/4" (Roofing)	12.00	10.10	8.55
B) Aglime			
Bulk dry	$15.10		
Bulk wet	14.30		
Regular 20 kg bags	55.25	40 kg bags $39.85	
Superfine		40 kg bags $55.70	

Dead-burned limestone is a high magnesium limestone which has been calcined at temperatures over 1400°C and is no longer reactive. It is used for the maintenance of furnaces and the manufacture of refractory bricks. These bricks are often bonded by tar or pitch and can contain fluxes such as mill scale or clay. In the United States, dead-burned dolomite production was 0.480 M tonnes in 1984 (L17, L18).

Companies and locations/sources and supplies. Within 800 kilometres of New Brunswick the limestone industry consists of:

Sydney Steel Corporation, Sydney, Nova Scotia - captive producer for steel mill

Mosher Limestone, Upper Musquodoboit, Nova Scotia - agricultural use

Havelock Lime, Havelock, New Brunswick - for agricultural use

Brookville Manufacturing Company - for agricultural use

Dresser Industries Canada Ltd., Kilmar, Quebec - for production of refractory-grade magnesia

Chromasco Corp., Haley, Ontario - raw material for production of magnesium metal

Dolomite Brick Corp. of America, York, Pennsylvania - manufacturer of dolomite refractories

A.P. Green Refractories Co., New Bethlehem, Pennsylvania - manufacturer of dolomite refractories (L17)

Specifications. The typical composition of dolomitic lime produced in the United States is given in Table 1.

Prices. In 1986, the average price for refractory dead-burned dolomite (f.o.b. plant, bulk) was $90.30 (Cdn) per tonne. (L2)

Substitutes. Refractory dolomite is one of many basic refractories; others include magnesia, chromite and forsterite. In recent years, the trend in steel making has been to basic refractories at the expense of acid refractories such as silica (see "Silica") and clay (see "Clay and Brick Shale"). However, within the basic refractory category, the trend has been to magnesia-carbon and others suited to the basic oxygen steelmaking process at the expense of chromium and doloma (dolanite) refractories.

Coincident with the loss of refractory markets has been an increase in the use of dolomitic lime as a slag-making flux. Practice has shown dolomitic lime improves refractory life. (L18)

3.3 Lime

Uses and quantities. For lime, the major uses in Canada in 1983 were (see Figure 5): iron and steel plants (46.2 percent) and pulp and paper mills (11.4 percent). (L2) In the United States (1986) the major uses were steel, BOF* (25.4 percent), water purification (11.1 percent), sulphur removal from stack gases (9.2 percent), paper and pulp (8.3 percent), steel, electric (6.1 percent), and sugar refining (4.8 percent). (L3) See Tables 6 and 7.

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*BOF is basic oxygen furnace

FIGURE 5

CANADIAN CONSUMPTION OF LIME
(QUICKLIME & HYDRATED) BY USE, 1983 (L2)

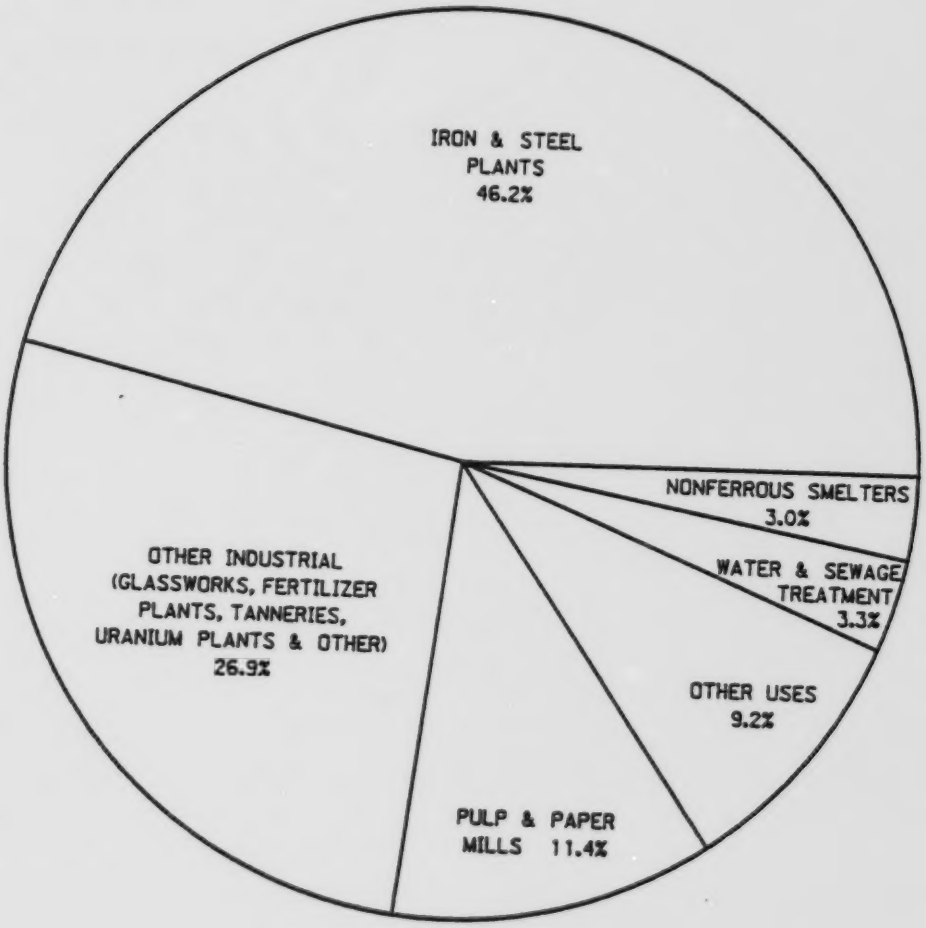

TABLE 6

CANADIAN CONSUMPTION OF LIME
(QUICKLIME AND HYDRATED) BY USE, 1983
(L2)

Use	Quantity tonnes (M)	%
Chemical and metallurgical		
Iron and steel plants	1.031	46.2
Pulp and paper mills	0.254	11.4
Water and sewage treatment	0.073	3.3
Nonferrous smelters	0.068	3.0
Cyanide and flottion mills	0.048	2.2
Sugar refineries	0.028	1.3
Other industrial (glassworks, fertilizer plants, tanneries, uranium plants and other)	0.601	26.9
Agricultural	0.017	0.8
Road stabilization	*	*
Other uses	0.112	5.0
TOTAL	2.232	100.0

*with "Other industrial"

TABLE 7

LIME SOLD OR USED IN THE UNITED STATES, 1986
(L3)

Use	Quantity tonnes (M)	Quantity %
Agriculture	0.051	0.4
Chemical and industrial		
Steel, BOF	3.680	25.4
Water purification	1.610	11.1
Sulphur removal from stack gases	1.341	9.2
Paper and pulp	1.198	8.3
Steel, electric	0.883	6.1
Sewage treatment	0.540	3.7
Alkalies	0.118	0.8
Sugar refining	0.689	4.8
Magnesia from seawater or brine	0.398	2.7
Copper ore concentration	0.335	2.3
Acid water, mine or plant	0.286	2.0
Steel, open-hearth	0.122	0.8
Calcium carbide	W	W
Glass	0.142	1.0
Aluminum and bauxite	0.174	1.2
Precipitated calcium carbonate	W	W
Ore concentration, other	0.130	0.9
Oil and grease	W	W
Tanning	0.022	0.2
Petroleum refining	0.010	0.1
Food products, animal or human	0.017	0.1
Oil well drilling	0.011	0.1
Metallurgy	0.010	0.1
Fertilizer	0.005	**
Brick, sand-lime	W	W
Paint	0.002	**
Other	0.906	6.2
Construction		
Road stabilization	0.481	3.3
Soil stabilization	0.417	2.9
Finishing lime	0.221	1.5
Mason's lime	0.214	1.5
Other	0.061	0.4
Refractory dolomite	0.424	2.9
TOTAL	14.498	100.0

W - withheld, with "other"
**- less than 0.1 percent

3.3.1 Iron and Steel

Description. Lime has two main uses in steel making. As quicklime, it acts as a flux helping to remove unwanted impurities such as phosphorus, silica and sulphur from the melt. Lime is also used as a refractory. Open-hearth steel furnaces often have dead-burned dolomite as a liner in their bottoms. The material helps extend the life of the furnace lining. In basic oxygen furnaces (BOF), tar-bonded, dead-burned dolomite refractory bricks are used. In some cases dolomitic lime is mixed with quicklime for fluxing to help extend refractory life. (L3)

Companies and locations. The names, locations and sizes of major steel mills within 800 kilometres of New Brunswick are presented in Table 8. In terms of market potential, the economic radius for lime for steel production is likely within 200-300 kilometres of a steel mill, or less.

Sources and suppliers. Lime is an undifferentiated product for most applications. Thus, the market area for lime is defined by the nearest alternative supply source. Lee and Adams in Massachusetts and Lime Ridge, St. Adolphe de Dudswell and Joliette in Quebec are the closest lime producers to Havelock Lime (Havelock) in New Brunswick. Thus the market area for Havelock is likely not 800 kilometres (see Table 9) but approximately midway between it and these other sources. This area would include Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick, Gaspé-Quebec, and eastern Maine.

Specifications. Grain size is important in iron and steel production as limestone fines can reduce the efficiency of iron making. Modern practice avoids this problem by sintering iron ore, coke and limestone into lumps which then become the charge for the production of pig iron. For sintering, one company requires limestone be finer than 5 mm but 90 percent be larger than 0.15 mm.

TABLE 8

MAJOR STEEL MILLS WITHIN 800 KILOMETRES OF NEW BRUNSWICK*

Province/State	Company	Location
Nova Scotia	Sydney Steel Corporation	Sydney
Quebec	Sidbec-Dosco Inc.	Montreal
Ontario	Algoma Steel Corp. Ltd.	Sault Ste. Marie
	Dofasco Inc.	Hamilton
	Stelco Inc. - Hilton Works	Hamilton
New York	Republic Steel Corp.	Buffalo
Pennsylvania	Allegheny International Inc.	Pittsburgh
	Bethlehem Steel Corp.	Bethlehem
	Carpenter Technology Corp.	Reading
	Cyclops Corp., Cytemp Specialty Steel Div.	Titusville
	Latrobe Steel Co., Sub. of The Tinker Co.	Latrobe
	Sharon Steel Corp.	Sharon
	Shenango Inc.	Pittsburgh
	Standard Steel Latrobe	Latrobe
	Wheeling-Pittsburgh Steel Corp.	Monessen
	Wheeling-Pittsburgh Steel Corp.	Pittsburgh

*All have over 1000 employees.

TABLE 9

PRODUCERS OF LIME WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(L2, L4, L6-L11)

Province/State	Company	Location	Size	Notes
New Brunswick	Havelock Lime (Div. of Dickenson Mines Limited)	Havelock	01	
Quebec	Domlim Inc.	Lime Ridge St. Adolphe de Dudswell	01	
	Jolichaux Inc.	Joliette	NA	
	Quebec Sugar Refinery	St.-Hilaire	NA	Production for captive use
Ontario	The Algoma Steel Corporation Limited	Sault Ste. Marie	04	Production for captive use
	Allied Chemical Canada Ltd.	Amherstburg	04	Production for captive use
	BeachviLime Limited	Beachville	03	
	Guelph DoLime Limited	Guelph	02	

TABLE 9 (continued)

Province/State	Company	Location	Size	Notes
Ontario (continued)	Timminco Limited	Haley	NA	Production for captive use
	Reiss Lime Company of Canada Limited	Spragge	01	
	Stelco Inc.	Ingersoll	02	
	Steetley Industries Limited, Steetly Lime Div.	Dundas	03	
Massachusetts	Lee Lime Corp.	Lee, Birkshire Co.	02	
	Pfizer Inc.	Adams, Birkshire Co.	04	
New York	Allied Chemical Corp.	Onondaga Co.	NA	
Pennsylvania	Bethlehem Steel Corp.	Adams and Lebanon Cos.	NA	
	Mercer Lime & Stone Co.	Butler Co.	02	
	Warner Co.	Centre and Chester Cos.	02	

Side Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

Chemical purity is not critical but high CaO content is important with low concentrations of silica, sulphur and phosphorus (under 1 percent total). (L4)

Prices. In December 1984 Canadian prices (Cdn $) for lime by carloads and truckloads f.o.b. plant (L2) were:

high calcium quicklime - bulk	$63.60/tonne
high calcium hydrated - bulk	$66.40/tonne

In 1986, in the United States average prices (Cdn$) for lime sold in bulk f.o.b. plant for industrial use were (L3):

overall, lime	- $ 74.10/tonne
quicklime	- $ 70.25/tonne
hydrated lime	- $119.00/tonne

Recent lime prices (Cdn$) from the Chemical Marketing Reporter are: (L23)

Lime, chemical, pebble (quicklime), bulk, 22,680 kg, works, f.o.b. plants	$52.80-$61.00/tonne
Lime, chemical, hydrated, bulk, same basis	$62.30-$67.70/tonne
bags, same basis	$73.15-$77.20/tonne

3.3.2 Pulp and Paper

Description. The two major lime uses are the preparation of digesting liquor and pulp bleaching. Among the digesting liquors which use lime are:

1) sulfate liquor. In the sulfite pulping process calcium bisulfite is the principal reactive chemical. It is produced by reacting fine limestone with sulphur dioxide gas.
$2SO_2 + H_2O + CaCO_3 \text{ ---> } Ca(HSO_3)_2 + CO_2$

This process is becoming less common as it creates significant quantities of pollution from waste chemicals (recycling is not possible).

2) sulfate liquors (white, black, green). The sulfate or kraft process is the most common pulping process. One of the reasons for its widespread use is that many of its chemicals are recycled resulting in a low pollution level.

White liquor is the reactive chemical mixture and consists mainly of sodium sulfide (Na_2S) and caustic soda (NaOH). After the pulping process, the liquor is known as **black liquor** and contains organic material (thus its black colour), sodium sulfate (Na_2SO_4), sodium carbonate (Na_2CO_3), salt, silica, and traces of other compounds. The black liquor is concentrated and burned. At the furnace the organic chemicals are burned and inorganics melted as well:
$Na_2SO_4 + 2C \longrightarrow Na_2S + 2CO_2$.

When the melted chemicals are mixed with lime, the liquor becomes **green liquor**. The key reaction is:
$NaCO_3 + Ca(OH)_2 \longrightarrow 2NaOH + CaCO_3$
The calcium carbonate precipitates, is collected and calcined for reuse. As the precipitates and impurities settle, the green liquor becomes **white liquor**.

Sodium chlorite is a common bleach for kraft paper and textiles. It is made through a series of chemical reactions which convert chlorine to calcium chlorate to chlorine dioxide and finally:
$4NaOH + Ca(OH)_2 + C + 4ClO_2 \longrightarrow 2NaClO_2 + CaCO_3 + 3HO_2O$

Sodium chlorite is a powerful but stable chemical agent. It also can serve as a source of chlorine dioxide, another pulp bleach chemical:
$NaClO_2 + Cl_2 \longrightarrow NaCl + ClO_2$

Companies and locations. The names and locations of sulfite mills within 800 kilometres of New Brunswick are presented in Table 10.

The names and locations of sulfate mills within 800 kilometres of New Brunswick are presented in Table 11.

Sources and suppliers. See "Iron and Steel" Section 3.3.1.

Prices. The prices presented in Section 3.3.1 (Iron and Steel) applied for pulp and paper as well.

Specifications. Composition is a key variable for lime used in pulp and paper. High concentrations of calcium and calcium plus magnesium (95 percent plus as oxide or hydroxide) are preferred but lower concentrations are acceptable as long as the composition is uniform and does not contain unwanted impurities (iron, for example).

In the sulfite process dolomitic lime is preferred to high calcium lime because of the higher solubility of magnesium sulfite to calcium sulfite. In the alkaline process the green liquor requires a hydrate with a high calcium content.

For all the above applications fine grain sizes are preferred for ease of handling and enhanced chemical activity. (L12)

Substitutes. For many years calcium was the preferred base source for the sulfite process because of lime's abundance and relative low cost. However, calcium sulfite is unable to pulp some woods and has problems with cooking time, chemical recovery and pollution.

TABLE 10

BLEACHED AND UNBLEACHED SULFITE PULP MILLS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK (L25)

Province/State	Company	Location	Capacity (tonnes/day)
New Brunswick	Fraser Inc.	Edmundston	360 (bleached)
	Fraser Inc.	Edmundston	180 (unbleached)
	Atholville Pulp, Inc.	Atholville	360 (bleached)
Newfoundland	Abitibi-Price Inc.	Grand Falls	210 (unbleached)
	Corner Brook Pulp and Paper Ltd.	Corner Brook	210 (unbleached/ semi-bleached)
Nova Scotia	Bowater Mersey Paper Co. Ltd.	Liverpool	145 (unbleached)
	Stora Forest Industries	Port Hawkesbury	455 (bleached)
Quebec	Price Co. Ltd.	Beaupre	295 (unbleached)
	CIP Inc.	Trois Rivieres	220 (unbleached)
	Consolidated-Bathurst Inc.	Grand Mere	135 (unbleached)
	Consolidated-Bathurst Inc.	Shawinigan	150 (unbleached)
	Consolidated-Bathurst Inc.	Ville de la Baie	220 (unbleached)

TABLE 10 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Quebec (continued)	Domtar Inc.	Dolbeau	180 (unbleached)
	Donohue Inc.	Clermont	135 (unbleached)
	Gaspesia Pulp & Paper Co. Ltd.	Chandler	135 (unbleached)
	James MacLaren Industries Inc.	Masson	250 (unbleached)
	Kruger Inc.	Trois Rivieres	230 (unbleached)
	The Price Co. Ltd.	Alma	200 (bleached)
	Quebec & Ontario Paper Co. Ltd.	Baie Comeau	360 (unbleached)
	Rayonier Quebec Inc.	Port Cartier	680 (bleached)
	Reed Paper Ltd.	Quebec City	455 (unbleached)
	St. Raymond Paper Inc.	Desbiens	110 (unbleached)
	Tembec Inc.	Temiscaming	635 (bleached)
Ontario	Abitibi-Price Inc.	Iroquois Falls	270 (bleached and unbleached)
	Abitibi-Price Inc.	Thunder Bay	115 (unbleached)
	Boise Cascade Canada Ltd.	Kenora	220 (unbleached)
	Quebec & Ontario Paper Co. Ltd.	Thorold	220 (unbleached)
	Spruce Falls Power & Paper Co. Ltd.	Kapuskasing	180 (unbleached)

TABLE 10 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Ontario (continued)	The Great Lakes Forest Products Ltd.	Thunder Bay	1280 (bleached)
Maine	Great Northern Paper Co.	Millinocket	645 (unbleached)
Massachusetts	Rising Paper Co.	Housatonic	45 (bleached)
New York	Finch, Pruyn & Co. Inc.	Glens Falls	345 (bleached)
Pennsylvania	Proctor & Gamble Paper Products Co.	Mehoopany	Not available (bleached)

TABLE 11

BLEACHED AND UNBLEACHED SULFATE MILLS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK (L25)

Province/State	Company	Location	Capacity (tonnes/day)
New Brunswick	Miramichi Pulp & Paper Inc.	Newcastle	600 (bleached)/ unbleached)
	Irving Pulp and Paper Ltd.	Saint John	745 (bleached)
	St. Anne Nackawic Pulp & Paper Co. Ltd.	Nackawic	680 (bleached)
Nova Scotia	Scott Maritimes Ltd.	Abercrombie Point	545 (bleached)
Quebec	Cascades (Jonquiere) Inc.	Jonquiere	180 (bleached)
	Cascades (East Angus) Inc.	East Angus	180 (unbleached)
	CIP Inc.	La Tuque	420 (bleached)
	Consolidated Bathurst Inc.	Portage-du-Fort	570 (bleached)
	Consolidated Bathurst Inc.	New Richmond	645 (unbleached)
	Consolidated Bathurst Inc.	Trois Rivieres	270 (unbleached)

TABLE 11 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Quebec (continued)	Domtar Inc.	Lebel-Sur-Quevillon	750 (bleached/ (unbleached)
	Domtar Inc.	Windsor	360 (bleached) 55 (unbleached)
	Donohue St.-Felicien Inc.	St.-Felicien	730 (bleached)/ (unbleached)
	James MacLaren Industries Inc.	Thurso	330 (bleached)
	St. Raymond Paper Ltd.	Saint Raymond	145 (bleached)
Ontario	Abitibi-Price Inc.	Smooth Rock Falls	290 (bleached)
	Boise Cascade Canada Ltd.	Fort Frances	465 (bleached)
	Domtar Inc.	Cornwall	410 (bleached)
	Domtar Inc.	Red Rock	45 (bleached) 659 (unbleached)
	E.B. Eddy Forest Products Ltd.	Espanola	733 (bleached/ (unbleached)
	Great Lakes Forest Products Ltd.	Thunder Bay	1288 (bleached)
	Great Lakes Forest Products Ltd.	Dryden	655 (bleached)
	James River-Marathon Ltd.	Marathon	455 (bleached)

TABLE 11 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Ontario (continued)	Kimberly-Clark of Canada Ltd.	Terrace Bay	1 135 (bleached)
Maine	Boise Cascade Corp.	Rumford	590 (bleached)
	Georgia-Pacific Corp.	Woodland	730 (bleached)
	International Paper Co.	Jay	1 020 (bleached)
	Madison Paper Industries	Madison	345 (bleached)
	Lincoln Pulp & Paper Co.	Lincoln	320 (bleached)
	Scott Paper Co.	Hinckley	820 (bleached)
	S.D. Warren Co.	Westbrook	270 (bleached)
New Hampshire	James River Corp.	Berlin	730 (bleached/ unbleached)
New York	International Paper Co.	Ticonderoga	480 (bleached)
Pennsylvania	Appleton Paper Inc.	Roaring Spring	165 (bleached)
	The P.H. Glatfelter Co.	Spring Grove	500 (bleached)
	Penntech Papers Inc.	Johnsonburg	200 (bleached)

Other bases such as sodium, magnesium and ammonia form bisulfites which are more soluble than calcium sulfite and work better. When chemical recovery is practiced these other bases often become more economic. In recent years, magnesium in particular has tended to supplant calcium in the sulfite process and will likely continue to do so.

For green liquor, hydrate has no substitute. The causticizing-calcining process is a closed loop which uses low cost abundant hydrate and creates by-product lime mud which in turn can be calcined and hydrated.

Either sodium hydroxide or hydrate can be used to produce hychlorite and each method has advantages and disadvantages. Displacement of one by the other will depend upon which chemical works best with process changes~ and improvements. (L12)

3.3.3 Water and Wastewater Treatment

Description. Lime is used in a number of water and wastewater treatment processes. In many parts of North America (Canadian Prairies, midwestern and southwestern United States) "hard" water causes problems with scale formation in boilers, heaters, and hot water systems and scum formation with many cleaning processes. Water hardness is caused by a high concentration of metal ions*. Hydrate, soda ash and carbon dioxide can be used to soften hard water through a series of chemical reactions involving pH changes and the formation of insoluble precipitates ($CaCO_3$, $Mg(OH)_2$) (L13):

---

*The principal ions causing hard water are: Ca++, Mg++, Sr++, Fe++, and Mn++. Associated with these cations are the anions: HCO_3^-, $SO_4^=$, Cl^-, NO_3^-, $SiO_3^=$

$$Ca^{++} + 2HCO^{-}_{3} + Ca(OH)_2 \text{ ---> } 2CaCO_3 + 2H_2O$$

$$Mg^{++} + 2HCO_3^{-} + Ca(OH)_2 \text{ ---> } CaCO_3 + Mg^{++} + CO_3 + 2H_2O$$

$$Mg^{++} + CO_3^{=} + Ca(OH)_2 \text{ ---> } CaCO_3 + Mg(OH)_2$$

Lime aids the coagulation process for some precipitates by raising the pH. Ortho- and polyphosphates are often removed from wastewater by hydrate addition as they are less soluble in high pH water than low pH water. (L14)

Acid mine drainage from open pits, strip mines, and primary processing (crushing, sorting) is often treated with lime (quicklime or hydrate) to neutralize the pH before release to lakes or streams.

Many wastewater sludges are treated with lime to assist in dewatering, improve handling, and kill pathogenic organisms.

In addition to the large volume uses listed above, several other water and wastewater treatment processes use lime for pH control. For example, the manganese removal, water treatment plant in Fredericton uses about 140 tonnes of lime each year.

Users and locations. Potential users of lime for water and wastewater treatment include municipalities, municipal service districts, large thermal power stations, coal and metal mines, and large industrial establishments (pulp and paper mills, steel mills).

Suppliers and sources. See "Iron and Steel", Section 3.3.1.

Specifications. Grain size and composition are the key parameters. Fine grain size allows for faster and more effective reactions. High calcium hydrate is preferred as calcium is the

essential element. Small concentrations of magnesium, iron, silica and alumina are acceptable but heavy metals impurities are not.

Prices. For large volume users, the prices quoted for "Iron and Steel" would apply for water and wastewater, as well. However, in some cases the order quantities would be small and prices similar to those for construction lime.

Construction lime, bulk, f.o.b. plant (Cdn$):
overall, lime $ 97.30/tonne
quicklime $ 79.70/tonne
hydrated lime $102.00/tonne (L3)

See also Table 12.

Substitutes. Soda ash and sodium bicarbonate are sometimes used in place of lime for pH control. They are easier to use, more soluble, do not form scale and allow finer pH control, but are much more expensive.

Limestone has been used and is preferred in acid-rain applications (see limestone).

Zeolites, natural and synthetic, are used for water softening instead of the lime-carbon dioxide method. The zeolite is regenerated with brine or salt (NaCl). (L13, L14)

3.3.4 Sugar Refining

Description. Hydrate is used to raise the pH of the sugar liquor and cause colloidal impurities to precipitate. This process leaves hydrate as the significant non-sugar impurity in the liquor; it is removed by agitating the liquor with carbon dioxide. The carbon dioxide and hydrate react to form calcium carbonate which is filtered from the liquor. (L4)

TABLE 12

PRICES (IN CANADIAN DOLLARS)* PAID FOR CONSTRUCTION LIME IN LARGE CITIES WITHIN 800 KILOMETRES OF NEW BRUNSWICK (L16)

Product	City	1986				1987			
		January	April	July	October	January	April	July	October
Lime, in paper, hyd. fin.	Montreal	$437	437	431	431	538	538	538	538
	Boston	253	239	239	253	253	253	253	253
	New York	130	130	-	-	-	-	-	-
	Philadelphia	221	221	221	221	221	221	277	277
Lime, in paper, com. hyd.	Montreal	296	296	279	279	347	347	343	343
	Boston	120	120	120	120	120	120	120	120
	New York	130	130	-	-	-	-	-	-
	Philadelphia	181	189	189	189	189	189	192	192
Lime, in paper, pulverized	Montreal	296	296	299	299	373	373	373	373
	Boston	120	120	120	120	120	120	120	120
Lime, in paper, common lump	Montreal	301	301	299	299	373	373	373	373
	Boston	120	120	120	120	120	120	120	120

*$1 Cdn = $0.75 US

Because hydrate and carbon dioxide are both used in sugar refining and calcium carbonate is a by-product, many refineries have lime kilns on the premises. The calcium carbonate by-product is calcined to form quicklime and carbon dioxide. The quicklime is mixed with water to form milk of lime. The process becomes a loop with only small quantities of makeup lime required.

Companies and location. Large sugar refineries within 800 kilometres of New Brunswick are presented in Table 13.

Sources and suppliers. See "Iron and Steel" Section 3.3.1.

Specifications. A high calcium lime is used with few impurities. One standard calls for at least 96 percent $CaCO_3$ in the limestone source with 1 percent maximum of each of SiO_2, Fe_2O_3 plus Al_2O_3, MgO, and clay plus sulphates plus organics.

Prices. Chemical grade lime is used. Prices would be similar to those for "Water and Wastewater" Section 3.3.3.

Substitute. There is no common substitute for lime in sugar refining.

3.3.5 Construction

Description. In recent years construction has become a minor consumer of lime. Typical uses include the use of lime to stabilize the clay soils for bases and subbases for roads, railroads, dams, runways, and buildings and the incorporation of lime in sanitary landfill sites for leachate neutralization.

TABLE 13

LARGE SUGAR REFINERIES WITHIN 800 KILOMETRES OF NEW BRUNSWICK

Province/State	Company	Location	Size	Products
New Brunswick	Lantic Sugar Limited	Saint John	04	White sugar
Quebec	Industries Redpath Limitee	Montreal	NA	Refined sugar and cane molasses
	Natalik Inc.	Montreal	04	Refined sugar
	La Raffinerie de Sucre du Quebec	Mont-St-Hilaire	04	Raw sugar, molasses, beet pulp with molasses
	Sucre Atlantic Limitee	Montreal	03	Sugar
Ontario	Canada Starch Company Inc.	Cardinal	04	Corn oil, corn starch, corn syrup, glucose, high fructose corn syrup and other products
	Redpath Industries Ltd.	Chatham	01	Beet sugar
	Redpath Industries Ltd.	Toronto	04	Refined sugar, molasses
	St. Lawrence Starch Co. Ltd.	Mississauga	04	Corn products - syrups, glucose, oil sugar, starches and a few other products

TABLE 13 (continued)

Province/State	Company	Location	Size	Products
Ontario (continued)	West Cane Sugar	Oshawa	03	Sugar
	Zymaize Company	London	03	High fructose corn syrup
Massachusetts	Revere Sugar Corp.	Woburn	04	Sugar
Connecticut	American Maize Products Co.	Stamford	04	Corn wet milling, corn sweeteners and other products
	Ingredient Technology Corp.	Darien	04	Molasses and other products
New York	H. Foy & Co. Inc.	Brooklyn	02	Syrups
	Refined Syrups & Sugars Inc.	Yonkers	NA	Liquid and granulated sugars, blends
New Jersey	CPC International Inc.	Englewood Cliffs	04	Corn starch, corn oil, corn syrup, high fructose corn syrup and a few other products
Pennsylvania	Flavoripe Co. Inc.	Pittsburgh	02	Syrups, sugar

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

3.4 Consumption Estimates

Pulp and Paper. The amount of hydrated or calcined lime used in a pulp and paper mill is dependent upon several factors including: type of pulping process (sulfite mills tend to use more lime than sulfate mills), age of mill (newer processes use less lime per tonne of output), the presence or absence of bleaching facilities (calcium hypochorite bleach is made with lime), size of mill (larger mills use more lime), and size and type of pollution control facilities (new mills and mills on rivers and streams tend to use much more lime for air and water pollution control than old mills or mills located on the seashore).

A further point is that most pulp and paper mills tend to buy their lime from at least two sources. The purpose of this policy is to ensure supply sources in the event of a disruption at one source (strike, fire).

With these points in mind, it appears that the average pulp and paper mill consumes 2000-3000 tonnes of hydrated or calcined lime each year. The range of consumption is from a few hundred tonnes to over 7000 tonnes per year.

In the extended market area of the Atlantic Provinces, the Gaspé and Maine, pulp and paper mills likely consume 60 000 - 70 000 tonnes of lime each year.

Steel mines. Quicklime is used as a flux in the steel making process. A rule of thumb is that 12-90 kg of quicklime is used per tonne of steel. Sydney Steel uses about 100 tonnes of lime each year. This is the only mill in the extended market area.

Pollution control. Many mines use hydrated or quicklime to neutralize acid runoff from strip mines or spoil piles. The amount used is dependent upon geological conditions (type of rock) and size of the mine operation. Brunswick Mines, for example, uses several thousand tonnes of lime each year.

Smelters and electric power plants can use several hundred tonnes of lime each year for stack scrubbers. The amount is dependent upon the concentration of sulfur in the fuel or ore. At present, this technology is not applied extensively in the Atlantic Provinces but once it is each coal- or oil-fired power plants and smelters could use thousands of tonnes per year.

Small amounts of lime are used for municipal water and waste-water treatment, 300 tonnes/year at the largest facilities.

In the extended market area it is estimated 30 000 - 40 000 tonnes of lime is used for pollution control each year.

Total. In the extended market area of the Atlantic Prvoinces, the Gaspé and Maine, total annual consumption of hydrated and quicklime is estimated at:

pulp and paper	60 000	- 70 000	tonnes
pollution control	30 000	- 40 000	
other uses	5 000	- 10 000	
Total	95 000	- 120 000	tonnes

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MANGANESE DIOXIDE

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MANGANESE DIOXIDE

1.0 INTRODUCTION

Definition. Manganese dioxide comes from two sources:

1) natural minerals such as pyrolusite, braunstein, and polianite; and

2) processing of other manganese compounds by electrolytic or chemical means.

Pryolusite is the most common source of manganese dioxide. It is a relatively rare mineral, found in commercial quantities in just a few countries notably Gabon, Ghana, Greece, and Mexico.

Synthetic manganese dioxide was first produced in 1918 using an electrolytic process. Since then, electrolytic manganese dioxide (EMD) has been produced by several different processes. In each case the EMD is either a by-product from potassium permanganate production or the product of upgrading a low-grade ore by electrolytic processes. In the latter case, manganese carbonate or manganese dioxide ore is roasted and reduced to manganese oxide. The oxide is dissolved in sulphuric acid and converted to EMD.

Chemical manganese dioxide (CMD) is produced by chemical extraction and processing of low-grade, non-oxide ores. A more recent process (1953), CMD production competes with EMD for most uses except heavy-discharge alkaline batteries which use EMD only.

A rule of thumb in the production of synthetic manganese dioxide is that 1.7 tonnes of ore of 45-50 percent manganese content will yield 1 tonne of manganese dioxide.

Activated manganese dioxide results from the treatment of natural manganese dioxide by chemicals. Usually about 50 percent of the manganese (Mn) is removed leaving a material which is more porous, hydrated, and chemically active than natural ore. (MD 1)

Special properties. Manganese dioxide has been used as a chemical reagent for many years, especially for dyes. (A reagent is a chemical used to analyze the constituents of a substance by reacting with it to produce a characteristic colour or by-product. Many manganese by-products have a bright purple colour.)

As well, manganese dioxide is a useful oxidizing agent and is used as such in the glass, steel, and chemical industries. For example, in steel manganese is used to remove oxygen and sulphur. (MD 1)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Manganese occurs at over 59 locations in New Brunswick. (MD 5) Several of these occurrences were mined in the late nineteen hundreds. Developments such as those at Jordon Mountain, Markhamville, Glebe, Gowland Mountain, Tetagouche Falls, and in the vicinity of Woodstock were associated with bedrock sources and were significant producers at one time. Most of these operations consisted of small underground mines which generally extracted only "high grade" zones for use in the steel industry.

Other deposits such as those in the Dawson Settlement and Renous areas consisted of bog manganese deposits. Manganese-rich waters flowing out of bedrock aquifers encountered conditions suitable for the precipitation of the manganese and deposits several feet thick accumulated over several acres. These readily extractable deposits were "concentrated" by combustion of organic components.

The importance of manganese as a "strategic" mineral for steel production was an important factor contributing to interest in the Province's manganese resources about the time of the two world wars. To encourage the development of the industry, the New Brunswick government in 1940 granted $11,000 for the use of the geologists and operators working manganese claims. In 1941 the grant was raised to $13,000 with an additional grant of $13,500 established for special mining investigations to determine the feasibility of further development. (MD 6) Considerable exploration and development work resulted.

After World War II, the concept pertaining to the strategic importance of manganese supply was reinforced and carried over into the 1950s. Manganese exploration, however, took on a different approach than earlier. The fast expanding steel industry was requiring larger tonnages of high grade metallurgical manganese. The small and erratic high grade deposits were more or less forgotten and attention was directed to the lower grade, high tonnage manganese deposits near Woodstock.

Although beneficiation of the Woodstock ore was felt to be feasible, interest dwindled by the 1960s due to the ready availability of low-cost imported material.

In the mid 1980s additional metallurgical work was carried out in the Woodstock area and an investigation of potential markets for nonmetallurgical uses was conducted. (MD 7) The study concluded that a market niche for manganese from the Woodstock deposits was unlikely to be available in the period up to the year 2000.

3.0 CONSUMPTION

Uses and quantities. Manganese chemicals such as manganese dioxide account for about 5 percent of total manganese ore consumption in Canada and the United States. (MD 2) The most commonly used manganese chemicals are manganese dioxide, manganese oxide, manganese sulphate, and potassium permanganate. Consumption figures for these chemicals are not readily available, due in part to the status of manganese as a strategic metal which is stockpiled. It is reported that 0.205 M tonnes of manganese ore was consumed in Canada in 1987 and 0.514 M tonnes in the United States in 1986; 5 percent of these values would yield 0.010 M tonnes and 0.025 M tonnes of ore consumed for manganese chemicals respectively. Table 1 provides consumption figures for Canada in 1975-1982; these figures show chemical consumption at 1-5 percent of total ore consumption.

The largest single use of manganese dioxide in both natural and synthetic forms is the production of dry-cell batteries. Worldwide, the annual consumption of manganese ore in batteries was estimated at 0.450 M tonnes in 1976. (MD 1) Assuming a 3 percent annual growth rate in battery use (a conservative assumption), consumption would be 0.640 M tonnes in 1988; at 5 percent growth, 0.810 M tonnes in 1988.

3.1 Dry-Cell Batteries

Description. A battery is designed to produce a flow of electrons (or electric current) through chemical reactions within the battery cell. Each cell has two electrodes - an anode and a cathode in a chemical bath; when the battery is in use the electrons flow from the cathode (usually carbon) to the anode (usually zinc). The importance of manganese dioxide is as

TABLE 1

CONSUMPTION OF MANGANESE ORE IN CANADA, 1975-1982 (MD 2)
(M TONNES)

Year	Metallurgical Grade	Battery and Chemical Grade	Total
1975	0.159	0.002	0.161
1976	0.236	0.002	0.238
1977	0.198	0.002	0.200
1978	0.199	0.002	0.201
1979	0.059	0.003	0.062
1980	0.154	0.003	0.158
1981	0.285	0.004	0.289
1982	0.127	0.003	0.131

a depolarizer. Using its oxidizing properties, manganese dioxide removes the waste products of the cell's chemical reaction through chemical conversion.* Without manganese dioxide the electrodes would become coated with waste products and the reaction would be short-lived.

The more reactive the manganese dioxide, the more powerful the battery current. Modern batteries require manganese dioxide with high reactivity, and usually use EMD, CMD or actuated manganese dioxide or a mixture of natural and synthetic material.

Companies and locations. Manufacturers of dry cell batteries within 800 kilometres of New Brunswick are listed in Table 2.

Sources and suppliers. The producers of EMD, CMD and activated manganese dioxide in the United States are presented in Table 3. There are no producers of manganese dioxide in Canada. (MD 2, MD 3)

Specifications. For EMD the standard dry-cell specification is MnO_2 - 91 percent, water - 2 percent, iron - 0.02 percent, copper - 0.0005 percent, lead - 0.0009 percent and pH of 6-7. (MD 1)

Prices. According to "Chemical Marketing Reporter" the following are July 1988 prices for manganese dioxide:

- Natural, African, ground
  74-76 percent MnO_2, 45 kg bags
  laevo, works $293 (Cdn)/tonne

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*In most cells, hydrogen is the waste product. Manganese dioxide reacts with the hydrogen providing oxygen and creating water - a useful agent for the "dry" cell.

TABLE 2

MANUFACTURERS OF DRY CELL BATTERIES WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(TRADE DIRECTORIES)

Province/State	Company	Location	Size	Notes
Quebec	Fulmen Inc.	Louiseville	03	Batteries
	Saft Batteries Limited	Valleyfield	01	Dry primary cells, industrial cells - alkaline and water-activated.
Ontario	Duracell Inc.	Mississauga	04	Industrial, commercial, consumer and military battery systems; primary and secondary including mercury, alkaline, etc.
	Eltra of Canada Limited	Maple	04	Batteries
	Saft Batteries Limited	Scarborough	02	Nickel alkaline batteries
	Union Carbide Canada Limited	Walkerton	04	Dry batteries
Vermont	Union Carbide Corp. Battery Products Division	Bennington	04	Dry batteries
Connecticut	Duracell Inc.	Bethel	04	Batteries
	Union Carbide/Battery Products Div., Div. Union Carbide Corp.	Danbury	N/A	Batteries
New York	Mallory Battery Co., Sub. of Dart Industries	Tarrytown	N/A	Dry cell batteries
New Jersey	Bright Star Industries Inc.	Clifton	04	Mfr. flashlight batteries

TABLE 2 (continued)

Province/State	Company	Location	Size	Notes
New Jersey (continued)	McGraw-Edison Co., Power systems Div.	Newark	04	Batteries
	Union Carbide Corp., Consumer Battery Div.	Edison	01	Batteries
Pennsylvania	Catalyst Research Corp. Div., Mine Safety Appliances Co.	Pittsburgh	N/A	Primary dry and wet batteries
	East Penn. Manufacturing Co.	Lyon Station	04	Batteries

N/A - not available

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

TABLE 3

PRODUCERS OF MANGANESE DIOXIDE
IN THE UNITED STATES, 1986 (MD 3)

State	Company	Location	Product
Maryland	Chemetals Inc.	Baltimore	CMD
Ohio	Foote Mineral Co.	New Johnsonville	EMD
Tennessee	RAYOVAC Corp., ESB Materials Co.	Covington	EMD
Mississippi	Kerr-McGee Chemical Corp.	Hamilton	EMD
Nevada	Kerr-McGee Cheical Corp.	Henderson	EMD

- Natural, same as above except 84 percent MnO_2 $365 (Cdn)/tonne

- Synthetic, crystalline, battery grade
  90-92 percent MO_2, 45 kg bags
  carload, works $2050 (Cdn)/tonne

Substitutes. There is no substitute for manganese oxide in dry-cell batteries. There has been a trend to the use of higher quality manganese dioxide sources such as activated manganese dioxide, EMB and CMD.

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SALT

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SALT

1.0 INTRODUCTION

Definition. "Salt" is the common word for the mineral halite or sodium chloride (NaCl) which is one of a large number of salts including calcium chloride, lithium chloride, potassium iodide, and other ionic compounds. However, salt will mean only sodium chloride for this report.

Special properties. Salt is an essential nutrient for life and has a long history of usage. The word "salary" comes from the Latin word for salt - "sal" - and refers to the Roman practice of paying soldiers with salt.

Salt is very soluble and helps reduce the freezing temperature of water. Road salt is widely used to melt ice and snow.

Most sodium and chlorine compounds are derived from salt, providing many useful chemicals for industry.

Few organisms can survive in a highly saline environment, this property made salt a useful food preserver. (S9)

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Salt springs have long been known to occur in the Kings County area of southern New Brunswick. The early settlers placed a high value on salt because of the food preservation properties and much of the eastern Canada supply was imported from England. However, there was a limited and sporadic production for local use from the salt springs in Kings County. Wood fires were used to boil brine in large kettles. Production started around 1800 and continued until about 1905 at Sussex. Salt probably was also produced at Salina in Kings County between 1850 and 1900. (S1) Development of salt production in Nova Scotia and Ontario provided a secure domestic supply and there was little interest in salt development in New Brunswick for several decades.

Chemical testing of a salt spring in 1954 suggested potash also to be present in the water. (S2) However, large expenditures were required to test this and the potential for large salt deposits remained unexplored, partially because it was felt there were insufficient markets for the product. However, the potential for deposits of potash associated with the salt combined with possible underground storage capabilities led to renewed interest. A government-sponsored drilling program was initiated in 1971 to test geophysical anomalies thought to be a result of subsurface salt deposits. The drilling program consisted of two boreholes and confirmed the existence of high grade salt in the Penobsquis area near Sussex. Potash was found in one of the drill holes and considerable interest was generated. A subsequent drilling program in 1973 confirmed the existence of two additional, separate salt deposits, both containing potash, in the Cassidy Lake/Salt Springs area and at Lower Millstream. The provincial government invited proposals for the rights to explore and subsequently develop these deposits.

The Potash Company of America (PCA) acquired the rights to the Penobsquis deposit in 1973 and is now producing both potash and salt. The Cassidy Lake (also called Clover Hill) deposit produces potash under the management of the Denison-Potacan Potash Company (DPPA). The Lower Millstream deposit has been explored by BP Resources Canada Ltd. (Selco Division). To date, the company has not reached a decision on a continuation of the exploration program by sinking of an exploration shaft to enable underground evaluation of the deposit. Additional information on the potash aspects of these developments are provided in the Potash section (Volume 1) of this report.

Deposits of salt and related materials such as those found in Sussex typically have several "zones" which reflect differences in chemical composition, purity and other factors. Zones of high purity salts; salt with inclusions such as clay; anhydrite beds; and other beds such as those containing potash, are common components of such deposits. The potash zones typically contain a mixture of the principal potash mineral sylvite (KCl) and the salt mineral halite (NaCl). This mixture is termed sylvinite and is essentially potash "ore". The higher the percentage of sylvite in the mixture, the higher the grade of the "ore".

In order to meet the specifications of the marketplace the potash and salt must be separated. This is accomplished by finely grinding the ore and using a series of chemical and/or mechanical methods such as flotation cells to extract the potash. The salt which remains, together with some other impurities, are referred to as "tailings" or waste rock. The obvious solution to tailings disposal would apparently be to sell the salt in the marketplace. However, the finely ground, impure material does not represent a high quality product, particularly for use in the chemical industry, and does not meet with market acceptance.

These salt tailings are not amenable to surface stockpiling as is normal practise with most mines because they will readily dissolve and create environmental problems. In New Brunswick tailings are returned underground to backfill space created by the mining. However, the crushing of the rock greatly increases the volume and only limited space is available for other purposes. Disposal of excess brine used in the processing and wastewater from the mine represents a substantial problem with several possible solutions. The DPPC operation uses a pipeline to transport such solutions to the Bay of Fundy where it is diluted and released into the sea. At PCA a more unique approach was undertaken. One section of the mine, a considerable distance from the main potash ore zone, is mined exclusively for high purity salt. This material is of sufficient quality to compete against the product from other producing mines in the region such as those in Nova Scotia and the Magdalen Islands. The salt is mined by the cut and fill method and brought to the surface through the existing infrastructure for the potash operation. The void created by the salt mining can then be used for excess tailings and brine disposal.

PCA completed a surface exploration program in 1976 and proceeded with construction of an exploration shaft for underground exploration in 1978. Salt was produced in 1980 as part of this exploration phase and has continued since that time. Table 1 presents some statistics for this production. Salt is extracted at a rate of 400,000 to 500,000 tonnes per year and is sold mainly to consumers in the eastern United States. (S3) The salt is marketed under a sales contract to the International Salt Company of New York through its Canadian subsidiary, Iroquois Salt Products Ltd. Primary markets are for road de-icing and chemical plants.

TABLE 1

GOVERNMENT ROYALTY REVENUE:* NEW BRUNSWICK SALT PRODUCTION (S19)
1981-1988

Year	Tonnes	Current Dollars (Thousands)	Constant 1987 Dollars (Thousands)
1981	NA	7.594	5.480
1982	NA	3.164	3.960
1983	NA	33.028	39.070
1984	NA	28.524	32.340
1985	NA	31.964	34.840
1986	NA	37.411	37.410
1987	NA	36.664	38.500
1988	NA	—	—

*Royalty calculated at 1 percent of salt selling price.

2.1 Production of Derived Chemicals

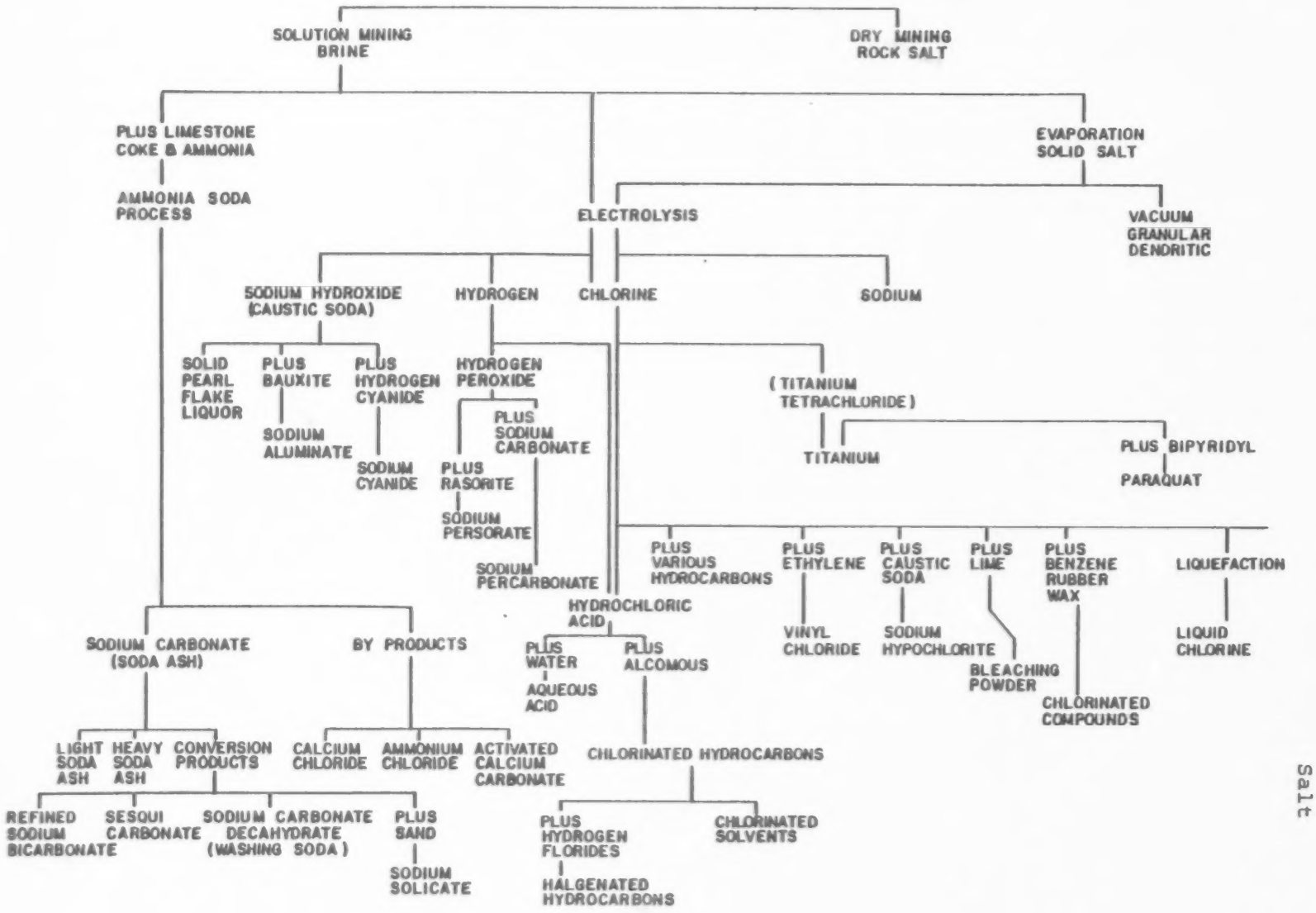
The industrial chemical manufacturing industry is one of the largest consumers of salt. The industry is often referred to as the chlor-alkali industry and involves the production of chlorine (Cl), caustic soda (or sodium hydroxide, NaOH), and numerous related commodities. The flow chart in Figure 1 gives an overview of the chemicals derived from salt.

Electrolysis of salt in an enclosed cell is an initial phase of chlor-alkali manufacture. Three methods are commonly used for electrolysis and all have slightly different raw material specifications. The salt used may be in the form of brine (about 80 percent of US consumption is in this form) or may be crystalline material which is dissolved on site. The major chlorine process is the diaphragm cell method, followed by mercury cells and membrane cells. The mercury cell method is declining in use in favour of membrane cells due to energy savings and higher environmental acceptance. The diaphragm cell method requires that calcium, magnesium, and iron levels in the salt be essentially nil and sulphate content be less than 0.5 percent. In the mercury cell method, low calcium is less important but magnesium, iron and other metals must be low. Membrane cell technology has even more stringent requirements and sodium sulphate content must be low.

Chlorine and caustic soda are the most important products and are produced in a constant ratio in the process. Production levels tend to be controlled by chlorine requirements since it is either liquid or gas and is difficult and expensive to store.

In New Brunswick there are two chlor-alkali plants. The St. Anne Chemical Company Ltd. at Nackawic uses membrane cell technology to produce chlorine (capacity is 9000 tonnes per year),

FIG. 1: SALT AND ITS CHEMICAL FAMILY, (S8)



caustic soda (10,000 tonnes), sodium chlorate (10,000 tonnes) and hydrochloric acid. The product goes to the adjacent pulp and paper mill. Additional caustic soda is also purchased.

The membrane cell process, patented by Asahi Chemical of Japan, is used at the plant. The process is based on the application of a direct current to the cell which forces the chloride ions in the treated salt brine to dissociate from the sodium ions. The chloride ions are discharged at the anode which liberates chlorine gas and the sodium ions migrate through the membrane into the cathode compartment. The ions associate with hydroyl from the demineralized water which liberates hydrogen gas at the cathode and produces a caustic soda solution.

The production of sodium chlorate involves the application of a direct current to a brine solution which causes the sodium chloride and water ions to rearrange into sodium chlorate and hydrogen gas. The hydrogen gas is cooled to release water and is compressed and fed to a HCl synthesis unit.

The second chlor-alkali plant is located at Dalhousie and is operated by CIL Inc. It uses mercury cell technology to produce chlorine (capacity 30,000 tonnes per year); caustic soda (33,000 tonnes), hydrochloric acid (5-10,000 tonnes) and hypochlorate (2-5000 tonnes).

Sodium carbonate or soda ash ($NaCO_3$) is another chemical for which there is a ready supply of raw materials in the Province. The material is produced synthetically by combining salt and lime in the Solvay Process. Most of the European production is by this method. At one time there were over 35 such operations in the United States but the last of these closed in 1986. (S6) The only remaining plant in North America is at Amherstburg, Ontario and was built in 1919. (S3) The plant uses brines recovered nearby for the supply of salt. High energy costs and

environmental concerns were a factor in the closure of the U.S. plants but the development of natural sodium carbonate (trona) mines in the western United States was the principal reason.

Sodium sulphate or soda cake (Na_2SO_4) is also known to naturally occur in New Brunswick. There are two reported occurrences in the Province, one at Weldon-Gautreau in Albert County and the other at Cornhill in Kings County. The occurrences consist of glauberite, an anhydrous sodium-calcium sulphate ($Na_2SO_4 \cdot CaSO_4$). The Albert County deposit is up to 9.1 metres thick and is estimated to contain 25 million tons grading 23 percent Na_2SO_4. However, the zone(s) occurs at depths of 289.5 to 217.6 metres. (S7) The depth of the zone is a constraint to development but solution mining could be considered.

3.0 CONSUMPTION

Uses and quantities. Salt consumption data for Canada is presented in Table 2. The two largest uses are snow and ice control (48.5%) and industrial chemicals (47.2%) (see Figure 2). (S10)

Data for the United States are presented in Table 3, the largest uses are chlor-alkali production (47.1%), ice control (26.2%) and food (many small quantity uses). Of total consumption, 8.7 percent is met by imported salt. (S11)

TABLE 2

SALT CONSUMPTION IN CANADA, 1985 (S10)

Use	Quantity tonnes (M)	percent
Snow and ice control	3.796	48.5
Industrial chemicals	3.695	47.2
Grain mills	0.073	0.9
Fishing industry	0.066	0.8
Slaughtering and meat processing	0.038	0.5
Pulp and paper mills	0.034	0.4
Fish processing	0.033	0.4
Miscellaneous food preparation	0.026	0.3
Fruit and vegetable processing	0.019	0.2
Bakeries	0.015	0.2
Dairy products	0.012	0.2
Leather tanneries	0.008	0.1
Miscellaneous textiles	0.004	0.1
Biscuits	0.002	**
Breweries	*	**
Other manufacturing industries	0.012	0.2
TOTAL	7.834	100.0

* less than 0.001 tonnes (M)

**less than 0.1%

FIGURE 2

SALT CONSUMPTION IN CANADA ,1985 (S10)

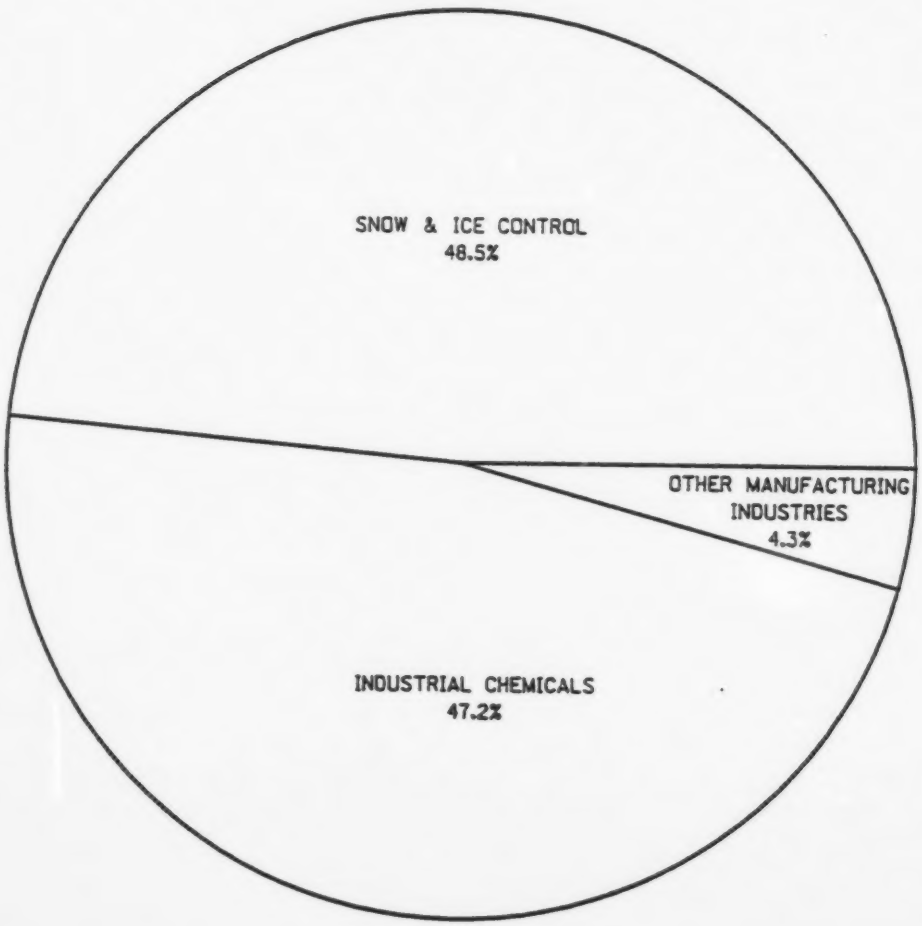


TABLE 3

SALT CONSUMPTION IN THE UNITED STATES, 1986 (S11)

Use	Quantity tonnes (M)	percent
Chemical:		
Chlor-alkali producers	17.239	47.1
Other	0.744	2.0
Food-processing industry:		
Meat packers	0.396	1.1
Dairy	0.094	0.3
Canning	0.246	0.7
Baking	0.122	0.3
Grain mill products	0.072	0.2
Other food processing	0.184	0.5
General industrial:		
Textiles and dying	0.205	0.6
Metal processing	0.276	0.8
Rubber	0.121	0.3
Oil	0.570	1.6
Pulp and paper	0.279	0.8
Tanning and/or leather	0.138	0.4
Other industrial	0.244	0.7
Agricultural:		
Feed retailers and/or dealer-mixers	0.854	2.3
Feed manufacturers	0.353	1.0
Direct-buying end users	0.034	0.1
Water treatment:		
Government	0.334	0.9
Commercial or other	0.144	0.4
Ice control:		
Government	9.270	25.3
Commercial or other	0.312	0.9

TABLE 3 (continued)

Use	Quantity tonnes (M)	percent
Distributors:		
Agricultural distribution	0.260	0.7
Grocery wholesalers and/or retailers	0.860	2.4
Institutional wholesalers and end users	0.136	0.4
Water-conditioning distribution	0.935	2.6
U.S. Government resale	0.008	**
Other wholesalers and/or retailers	1.415	3.9
Other	0.723	2.0
TOTAL	36.587	100.0

3.1 Chlor-alkali Industry

Description. The chlor-alkali industry involves the production of chlorine (Cl), caustic soda (NaOH), and soda ash ($NaCO_3$) from salt. Together with the manufacture of sulphuric acid and ammonia, chlor-alkali production is a vital part of the modern chemical industry.

3.1.1 Chlorine

Description. Chlorine gas is produced by the electrolysis of either salt or potassium chloride in an enclosed cell. Three common types of cell are diaphragm, mercury and membrane. The cells are named because of either their construction (membrane and diaphragm - important part in separating the very reactive products) or their electrodes (mercury). (S12)

In 1986 Canadian chlorine capacity was 1.5 M tonnes. In 1983, about 9.0 M tonnes was produced in the United States.

Use. About 20 percent of the chlorine produced in the United States and 41 percent in Canada is used to produce vinyl chloride monomer (VCM) which is the basis for a number of plastics including polyvinyl chloride (PVC). PVC is one of the most widely used plastics with applications ranging from toys, to record albums, to house siding, to plumbing. (S11)

The pulp and paper industry uses chlorine extensively (39 percent of consumption in Canada) as a bleaching agent. Bleaches react with wood lignin and other colorant materials attached to cellulose either making them soluble or changing the dark materials to a colorless form. Chlorine, hypochlorite, sodium chlorite, and chlorine dioxide are all used alone or in combination. Semichemical, sulfite, sulfate and groundwood pulps are all suitable for chlorine bleaches. (S13)

Water and sewage treatment uses chlorine compounds as disinfectants. For water supplies, chlorine, hypochloride and chlorine dioxide are used. The dosage is dependent upon the concentration of chlorine-reactive material in the water (as measured by chlorine demand). Good practice is to meet chlorine demand with a small chlorine residual present to treat any foreign material in the distribution system. (S14, S15)

Chlorine is also used to disinfect wastewater prior to discharge, especially if the discharge is close to a public beach or reaction area. However, this practice is becoming less common due to environmental concerns regarding chlorine compounds (chloramines). (S14, S15)

Companies and locations. The names and locations of chloride consuming sulfite and sulfate paper mills within 800 kilometres of New Brunswick are presented in Table 4 and Table 5, respectively.

Large chemical installations are location at Montreal, Sarnia, and throughout the northeastern United States.

Almost all water distribution systems in North America use chlorine to disinfect their water supplies.

Sources and suppliers. Table 6 presents a list of chlor-alkali plants within 800 kilometres of New Brunswick. Some of the plants are captive and supply only an adjacent chemical complex or pulp and paper mill, others produce chemicals for resale.

Specifications. The form and quantity of chlorine used for plastics manufacture, pulp and paper bleaching, and disinfection is dependent upon the properties of the other reactants (hydrocarbons, pulp, and water) and the desired characteristics of the final product. For example, bleaching is dependent upon the species of wood, type of cooking agent used for pulping and the characteristics of the cooking process itself. Thus specifications vary greatly. However, in many cases, the chlorine user makes the necessary adjustments, requiring only that the supplier provide chlorine (or a chlorine compound) of known concentration and purity.

Prices. In December 1988 the following prices ($Cdn) were reported (S19):

Chlorine, tanks, single units, works, $264-$271/tonne
f.o.b. freight equalized

TABLE 4

BLEACHED AND UNBLEACHED SULFITE PULP MILLS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK (S16)

Province/State	Company	Location	Capacity (tonnes/day)
New Brunswick	Fraser Inc.	Edmundston	360 (bleached)
	Fraser Inc.	Edmundston	180 (unbleached)
	Atholville Pulp, Inc.	Atholville	360 (bleached)
	NBIP Ltd.	Dalhousie	180 (unbleached)
Newfoundland	Abitibi-Price Inc.	Grand Falls	210 (unbleached)
	Corner Brook Pulp and Paper Ltd.	Corner Brook	210 (unbleached/ semi-bleached)
Nova Scotia	Bowater Mersey Paper Co. Ltd.	Liverpool	145 (unbleached)
	Stora Forest Industries	Port Hawkesbury	455 (bleached)
Quebec	Price Co. Ltd.	Beaupre	110 (unbleached)
	CIP Inc.	Trois Rivieres	220 (unbleached)
	Consolidated-Bathurst Inc.	Grand Mere	135 (unbleached)
	Consolidated-Bathurst Inc.	Shawinigan	150 (unbleached)
	Consolidated-Bathurst Inc.	Ville de la Baie	220 (unbleached)

TABLE 4 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Quebec (continued)	Domtar Inc.	Dolbeau	180 (unbleached)
	Donohue Inc.	Clermont	135 (unbleached)
	Gaspesia Pulp & Paper Co. Ltd.	Chandler	135 (unbleached)
	James MacLaren Industries Inc.	Masson	250 (unbleached)
	Kruger Inc.	Trois Rivieres	230 (unbleached)
	The Price Co. Ltd.	Alma	200 (bleached)
	Quebec & Ontario Paper Co. Ltd.	Baie Comeau	360 (unbleached)
	Rayonier Quebec Inc.	Port Cartier	680 (bleached)
	Reed Paper Ltd.	Quebec City	455 (unbleached)
	St. Raymond Paper Inc.	Desbiens	110 (unbleached)
	Tembec Inc.	Temiscaming	635 (bleached)
Ontario	Abitibi-Price Inc.	Iroquois Falls	270 (bleached and unbleached)
	Abitibi-Price Inc.	Thunder Bay	115 (unbleached)
	Boise Cascade Canada Ltd.	Kenora	220 (unbleached)
	Quebec & Ontario Paper Co. Ltd.	Thorold	220 (unbleached)
	Spruce Falls Power & Paper Co. Ltd.	Kapuskasing	180 (unbleached)

TABLE 4 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Ontario (continued)	The Great Lakes Forest Products Ltd.	Thunder Bay	1280 (bleached)
Maine	Great Northern Paper Co.	Millinocket	645 (unbleached)
Massachusetts	Rising Paper Co.	Housatonic	45 (bleached)
New York	Finch, Pruyn & Co. Inc.	Glens Falls	345 (bleached)
Pennsylvania	Proctor & Gamble Paper Products Co.	Mehoopany	Not available (bleached)

TABLE 5

BLEACHED AND UNBLEACHED SULFATE MILLS
WITHIN 800 KILOMETRES OF NEW BRUNSWICK (S10)

Province/State	Company	Location	Capacity (tonnes/day)
New Brunswick	Miramichi Pulp & Paper Inc.	Newcastle	600 (bleached)/ unbleached)
	Irving Pulp and Paper Ltd.	Saint John	745 (bleached)
	St. Anne Nackawic Pulp & Paper Co. Ltd.	Nackawic	680 (bleached)
Nova Scotia	Scott Maritimes Ltd.	Abercrombie Point	545 (bleached)
Quebec	Cascades (Jonquiere) Inc.	Jonquiere	180 (bleached)
	Cascades (East Angus) Inc.	East Angus	180 (unbleached)
	CIP Inc.	La Tuque	420 (bleached)
	Consolidated Bathurst Inc.	Portage-du-Fort	570 (bleached)
	Consolidated Bathurst Inc.	New Richmond	645 (unbleached)
	Consolidated Bathurst Inc.	Trois Rivieres	270 (unbleached)

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TABLE 5 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Quebec (continued)	Domtar Inc.	Lebel-Sur-Quevillon	750 (bleached/ (unbleached)
	Domtar Inc.	Windsor	360 (bleached) 55 (unbleached)
	Donohue St.-Felicien Inc.	St.-Felicien	730 (bleached)/ (unbleached)
	James MacLaren Industries Inc.	Thurso	330 (bleached)
	St. Raymond Paper Ltd.	Saint Raymond	145 (bleached)
Ontario	Abitibi-Price Inc.	Smooth Rock Falls	290 (bleached)
	Boise Cascade Canada Ltd.	Fort Frances	465 (bleached)
	Domtar Inc.	Cornwall	410 (bleached)
	Domtar Inc.	Red Rock	45 (bleached) 659 (unbleached)
	E.B. Eddy Forest Products Ltd.	Espanola	733 (bleached/ (unbleached)
	Great Lakes Forest Products Ltd.	Thunder Bay	1288 (bleached)
	Great Lakes Forest Products Ltd.	Dryden	655 (bleached)
	James River-Marathon Ltd.	Marathon	455 (bleached)

TABLE 5 (continued)

Province/State	Company	Location	Capacity (tonnes/day)
Ontario (continued)	Kimberly-Clark of Canada Ltd.	Terrace Bay	1135 (bleached)
Maine	Boise Cascade Corp.	Rumford	590 (bleached)
	Georgia-Pacific Corp.	Woodland	730 (bleached)
	International Paper Co.	Jay	1020 (bleached)
	Madison Paper Industries	Madison	345 (bleached)
	Lincoln Pulp & Paper Co.	Lincoln	320 (bleached)
	Scott Paper Co.	Hinckley	820 (bleached)
	S.D. Warren Co.	Westbrook	270 (bleached)
New Hampshire	James River Corp.	Berlin	730 (bleached/ unbleached)
New York	International Paper Co.	Ticonderoga	480 (bleached)
Pennsylvania	Appleton Paper Inc.	Roaring Spring	165 (bleached)
	The P.H. Glatfelter Co.	Spring Grove	500 (bleached)
	Penntech Papers Inc.	Johnsonburg	200 (bleached)

TABLE 6

CHLOR-ALKALI PLANTS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(S10, Trade Directories)

Province/State	Company (parent)	Location	Products	Capacity tonnes (M)	Notes
New Brunswick	St. Anne-Nackawic Pulp & Paper Co. Ltd. (Parsons and Whittemore)	Nackawic	sodium chlorate caustic soda chlorine	9 000 10 000 9 000	membrane cell, all to mill
	CIL Inc.	Dalhousie	caustic soda chlorine	31 000 28 000	mercury cell
Nova Scotia	Canso Chemicals Limited (CIL Inc.)	Abercrombie Point	caustic soda chlorine	20 000 18 000	mercury cell
Quebec	CIL Inc.	Becancour	caustic soda chlorine	325 000 295 000	diaphragm cell
	ERCO Industries of Canada Limited	Buckingham	sodium chlorate	88 000	—
	PPG Canada Inc. Industrial Chemial Div.	Beauharnois	sodium chlorate caustic soda chlorine	80 000 67 000 61 000	— mercury cells
	QueNord Inc.	Magog	sodium chlorate	90 000	—
Ontario	BCM Technologies Inc.	Amherstburg	sodium chlorate	45 000	—
	CIL Inc.	Cornwall	caustic soda chlorine	38 500 35 000	mercury cells
Maine	LCP Chemicals & Plastics Inc.	Orrington	caustic soda chlorine hydrochloric acid	— — —	employs 65 people
New York	Olin Corp. Industrial Chemicals Div.	Niagara Falls	caustic soda chlorine sodium methylate sodium chlorate	— — — —	employs 270 people

Substitutes. Several plastics compete with polyvinyl chloride (polyethylene, for example) but PVC is likely to remain widely used for some time to come because of its versatility and low cost.

Chlorine remains the most common bleaching agent in the pulp and paper industry because of its wide applicability and low cost. Competing bleaches include sodium and hydrogen peroxide (more effective for softwood), sodium bisulfite (groundwood), and sodium and zinc hydrosulfite (low cost bleach for groundwood). However, except for peroxide, none of the competing bleaches is likely to become widely used. (S13)

In wastewater treatment only ozone competes with chlorine. Ozone is widely used in Europe. It is slightly more expensive and does not have as effective residual properties as chlorine; however, it does not give a taste to water, either. Iodine and bromine are only rarely used. (S15)

3.1.2 Caustic Soda

Description. Caustic soda (sodium hydroxide), like chlorine, is produced by the electrolysis of salt. The caustic soda leaves the electrolysis cell in a salt solution containing 10-15 percent NaOH. The salt is then precipitated and the water evaporated to yield a 50 percent solution. The mercury cell yields a 50 percent solution directly. (S12)

In 1986 there was 1.7 M tonnes of caustic soda capacity in Canada, in 1983 United States production was 9.4 M tonnes.

Uses. In Canada the major uses of caustic are in aluminum smelting, glass manufacture, and the pulp and paper industry. In the United States the major uses are chemical manufacturing, the pulp and paper industry, soap and detergent manufacturing, the petroleum industry and glass manufacturing. (S9, S10)

Aluminum smelting is an electrolytic process which requires caustic soda or soda ash to help maintain sodium fluoride/ cryolite (3 $NaF.AlF_3$) equilibrium in the bath. (S12)

Soda (Na_2O) is the second most common material used in glass production (after silica) and constitutes 4-18 percent of most glass mixtures. Caustic soda and soda ash are used interchangeably as soda sources in glass production. Soda serves to flux silica sand during melting and to accelerate the melting process. Assuming soda consumption at 20 percent of silica consumption, Canada would be 0.170 M tonnes per year and United States, 1.9 M tonnes. (S17)

In the pulp and paper industry caustic soda (50 or 73 percent solution) is mixed with chlorine to produce sodium hypochlorite for bleaching. In addition, it is used (0.5-1.0 percent solution) as a treatment wash in sulfate bleaching; to deink and repulp paper for recycling (5.0 percent solution maximum); and in the pulping of nonwood fibres such as hemp, esparto and rags. (S13)

Caustic soda is an essential ingredient in the production of soap and detergent. Soaps are the sodium or potassium salts of fatty acids. They are made in a three-step process:

1) tallow (beef or mutton fat), vegetable oils (coconut), or grease (pure fat) is hydrolyzed under heat and pressure to produce glycerin and fatty acids;

2) the fatty acids are separated from glycerin and mixed with caustic soda to form salts of fatty acids; and

3) builders (such as sodium sulfate and soda ash) and additives (such as dyes and perfumes) are added to the salts to yield soap. (S12)

Detergents are much more complex than soap and are manufactured in five stages:

1) tallow is hydrolyzed;

2) the fatty acids undergo high-pressure hydrogenation and become tallow fatty alcohol;

3) the alcohol undergoes sulfation to produce sulfated tallow fatty alcohol;

4) the sulfated alcohol is mixed with caustic; and

5) builders and additives are added to the salts to yield detergents. (S12)

Among the synthetic fibres, drugs, dyes and chemicals which use caustic soda in their production are: rayon (from cellulose); dyes (from hydrocarbons); and drugs (barbital, aspirin, sulfa drugs). (S12)

Companies and locations. The names and locations of large aluminum smelters within 800 kilometres of New Brunswick are:

Alcan Smelters and Chemicals Ltd. - Alma, Que.
Alcan Smelters and Chemicals Ltd. - Arvida, Que.
Alcan Smelters and Chemicals Ltd. - Beauharnois, Que.
Alcan Smelters and Chemicals Ltd. - Shawinigan, Que.
Canadian Reynolds Metals Company Limited - Baie-Comeau, Que.

Aluminum Co. of America - St. Lawrence Co., NY
Reynolds Metals Co. - St. Lawrence Co., NY

Alumet Smelting Corporation - Essex Co., NJ

Pulp and paper mills within 800 kilometres of New Brunswick are presented in Tables 4 and 5.

Glass plants are listed in the chapter on Silica (Volume 2).

Soap and detergent manufacturers are listed in Table 7 and Table 8. S(19)

Sources and suppliers. Chlor-alkali plants within 800 kilometres of New Brunswick are listed in Table 6.

Specifications. Like chlorine, caustic is delivered in standard batches of known concentration and purity usually 76 percent NaO or 98 percent NaOH. The strength is then varied at the user facility to suit consumption conditions.

Prices. In December 1988 the following prices (Cdn$) were reported (S19):

TABLE 7

SOAP AND DETERGENT MANUFACTURERS* IN NEW BRUNSWICK
(Trade Directory)

Company	Location	Soaps	Detergents
Bristol-Myers Canada Inc. Bristol-Myers Manufacturing Div.	Moncton	—	household
Con-O-Lab Manufacturers Limited	Richibucto	soaps	detergents
Drift Hand Cleaner Ltd.	Bathurst	soaps	—
The Maritime Detergent Industry	Shediac	industrial	—
Star Industries	Moncton	—	cleaning detergents
Whisco Limited	Fredericton	—	detergents, cleaning compounds

All manufacturers in New Brunswick had less than 50 employees.

TABLE 8

MAJOR CANADIAN SOAP AND DETERGENT MANUFACTURERS*
WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(TRADE DIRECTORIES)

Province/State	Company	Location	Products	
			Soaps	Detergents
Ontario	Bristol-Myers	Toronto	-	Household
	Canada Packers Inc., Chemicals Division	Mississauga	Antiseptic, mechanics, green, industrial, laundry, liquid, powders, textile, waterless, wool, general	Anionic, general non-ionic, textile, synthetic
	CCL Industries Inc., Custom Mfg. Group	Willowdale	Household	Household
	Domtar Inc., Specialty Chemicals Division	Mississauga	Liquid	Anionic, general, household, nonionic, synthetic, textile
	Dubois Chemicals of Canada Ltd.	Weston	Antiseptic, industrial, laundry, liquid, wire drawing	General
	Dustbane Products Ltd.	Ottawa	Antiseptic, industrial, powders, waterless, wool	Anionic, general, non-ionic, synthetic
	Jergens	Mississauga	Castile, toilet	--
	Lever Brothers Ltd.	Toronto	Household, toilet	Household
	Proctor & Gamble Inc.	Toronto	Industrial, general	--

*Over 100 employees

Caustic soda, liquid, 50%, sellers tanks Gulf Coast works, f.o.b., freight equalized, 76% Na_2O	$312 - $373/tonne
73% same basis	373 - 434/tonne
flake, 76%, 180 kg drums, carload, works	835/tonne
Solid, 76%, 318 kg drums, carload, works	760/tonne
Granular, 75%, 204 kg drums, carload, works	760/tonne
Beads, 76%, 180 kg drums, carload, works	835/tonne

Substitutes. Caustic soda substitutes consist of other alkalis or other sources of soda. For example, in the preparation of hypochlorite in the pulp and paper industry either caustic or calcium hydroxide can be used. Caustic soda and soda ash are used interchangeably in the glass industry. In most cases caustic is maintaining its consumption share or improving its share.

3.1.3 Soda Ash

Description. At one time the Solvay process was widely used to produce soda ash (Na_2CO_3) from salt. However, high energy costs and environmental concerns on the process side and lower cost natural soda ash (trona) on the market side have reduced the use of the Solvay process drastically. The last remaining Solvay facility in the United States (Syracuse, NY) closed in 1986 (S6). However, much of the European production is still by this method and the General Chemical Company of Amherstburg, Ontario uses brines mined in the area to supply a Solvay plant. (S3)

3.2 Snow and Ice Control

Description. Salt-water solutions have lower melting temperatures than pure water. Thus, spreading salt on ice and snow promotes melting and helps keep affected areas free of ice and snow. Highways, sidewalks and parking lots are frequently salted through the winter months in cold climates.

Users and locations. Most de-icing salt is purchased by governments through their highways departments or public works divisions.

Sources and suppliers. Salt producers within 800 kilometres of New Brunswick are listed in Table 9.

Specifications. Most highway departments and public works groups have specifications for highway salt. These specifications have either been developed in-house or are based upon standards set by the Canadian Standards Association (CSA) or the American Society for Testing and Materials (ASTM). Exhibit 1 presents highway salt specifications from the New Brunswick Department of Transportation.

Prices. In 1986 the following prices were reported for Canada (bulk, f.o.b. at production works):

de-icing	$22- 42/tonne
fishery grade	$95-100/tonne
fine, evaporated	$80-105/tonne

Substitutes. Road salt is effective and inexpensive but has adverse effects upon the environment (plants and marine life), automobiles, bridges, and other steel and concrete structures. Calcium chloride is often used with road salt as it has a lower melting temperature; however, it is even more corrosive. Calcium magnesium acetate is another possible substitute and is currently being tested.

EXHIBIT 1

NEW BRUNSWICK DEPARTMENT OF TRANSPORTATION

Specifications for Bulk Highway Coarse Salt (Sodium Chloride)

This specification covers sodium chloride intended for use as a deicer for roads maintenance.

This specification covers sodium chloride obtained from natural deposits (rock salt) or produced by man (evaporated, solar, etc.).

(1) Chemical Requirements:

The sodium chloride shall conform to the following requirement as to chemical composition; Sodium Chloride (NaCl) 95.0 percent.

(2) Gradation Requirements:

The gradation of sodium chloride, when tested by means of laboratory sieves, shall conform to the following requirements for particle size distribution:

Sieve Size	Percent Passing by Weight
12.5 mm	100
9.5 mm	95 - 100
4.75 mm	20 - 90
2.36 mm	10 - 60
1.18 mm	0 - 10

(3) Permissible Variation:

In the case of sodium chloride sampled after delivery to the purchaser, tolerances from the foregoing specified values shall be as follows:

1. Chemical composition: 0.5 percentage point

2. Gradation: 5 percentage points on each sieve except the 12.5 mm and 9.5 mm.

(4) Moisture Content:

The moisture content of the sodium chloride shall not exceed one percent (1.0%) by weight.

Sodium chloride with a moisture content above one percent (1.0%) will not be accepted by the Department and must be removed.

(5) Anti-Caking Conditioner:

In order to prevent caking while in storage following delivery, all sodium chloride shall be uniformly treated with an anti-caking conditioner (YPS or equal). The conditioner shall be uniformly applied to the sodium chloride at a rate which when sampled shall have a minimum of 20 parts per million (P.P.M.).

(6) Condition:

The sodium chloride shall arrive at the purchaser's delivery point in a free flowing and usable condition.

(7) Inspection:

The purchaser or his representative shall be provided free entry and access at the storage areas for sampling. It is anticipated that determination for initial compliance will be made from samples obtained from the supplier's storage areas. Shipments to the purchaser's points of delivery may be randomly sampled for moisture content and gradation control. If in doubt complete analysis may be made on these samples. It is the intent of the purchaser to provide inside storage facilities for all sodium chloride shipments to insure a minimizing of increased moisture content. The supplier must be responsible for insuring a similar concern over moisture absorption in his storage areas.

(8) The Department reserves the right to have the supplier provide upon demand a written laboratory analysis of the salt supplied, including: chemical composition as to sodium chloride (NaCl) content; gradation; moisture content; and anti-caking conditioner content. This shall be incidental to the supply and will not constitute the basis for extra payment.

TABLE 9

SALT PRODUCERS WITHIN 800 KILOMETRES OF NEW BRUNSWICK
(S10, S18)

Province/State	Company	Location	Size*	Notes
New Brunswick	Potash Company of America	Sussex	01[1]	Initial production was in 1980. By-product rock salt from potash mine for use in snow and ice control. Shipments were approximately 475,500 tonnes.
Nova Scotia	The Canadian Salt Company Limited	Pugwash	03	Initial production was in 1959. Rock salt mining to a depth of 253 meters. Shipments in 1985 were approximately 684,000 tonnes.
	The Canadian Salt Company Limited	Pugwash	03	Initial production was in 1962. Dissolving rock salt fines for vacuum pan shipments in 1985 were approximately 82,300 tonnes.
	Domtar Inc., Sifto Salt Division	Nappan	02	Initial production was in 1947. Brining for vacuum pan evaporation. Shipments in 1985 were approximately 58,000 tonnes.
Quebec	Seleine Mines Inc.	Iles-de-la-Madeleine	04	Initial production was in 1982. Rock salt mining to a depth of up to 275 metres. Shipments in 1985 were approximately 997,000 tonnes.
Ontario	General Chemical Canada Ltd.	Amherstburg	01[1]	Initial production was in 1919. Brining to produce soda ash. Shipments in 1985 were approximately 618,100 tonnes.
	The Canadian Salt Company Limited	Ojibway	04	Initial production was in 1955. Rock salt mining at a depth of 300 m.

[1]Employment part of chemical complex.

*See end of table for size codes.

TABLE 9 (continued)

Province/State	Company	Location	Size*	Notes
Ontario (continued)	The Canadian Salt Company Limited	Windsor	03	Initial production was in 1892. Brining, vacuum pan evaporation and fusion. Shipments in 1985 were approximately 140,000 tonnes.
	Domtar Inc.	Goderich	04	Initial production was in 1959. Rock salt mining at a depth of 536 m. Shipments in 1985 were approximately 1,838,000 tonnes.
	Domtar Inc.	Goderich	02	Initial production was in 1880. Brining for vacuum pan evaporation. Shipments in 1985 were 98,000 tonnes.
	Dow Chemical of Canada Inc.	Sarnia	01[1]	Initial production was in 1950. Brining to produce caustic soda and chlorine. Shipments in 1985 were approximately 789,000 tonnes.
New York	Cargil Inc., Salt Div.	Schuyler Co.	02	Water softening, farm and feed, non-calcing, trace mineralized and solar salt.
	International Salt Co., Retsof Mine	Livingston Co.	04	Underground mine, export rock salt.
	Morton Salt Div., Div. of Morton Norwich Products Inc.	Wyoming Co.	02	Refined salt.

Size Code	Number Employed
01	0 - 49
02	50 - 99
03	100 - 199
04	Over 200

3.3 Consumption Estimates

Chlor-alkali processes. The chemical reaction for the chlor-alkali process is:

$$NaCl + H_2O \longrightarrow NaOH + \tfrac{1}{2}H_2 + \tfrac{1}{2}Cl_2$$

One tonne of salt plus 310 kilograms of water will yield 700 kilograms of caustic soda, 17 kilograms of hydrogen and 600 kilograms of chlorine gas. The hydrogen and chlorine, in turn, can be combined to produce hydrochloric acid. This mass balance assumes complete conversion of the brine to chlor-alkali chemicals.

Assuming 75 percent brine conversion efficiency, the chlor-alkali plant at St. Anne Chemical Company Ltd. in Nackawic uses 20 000 tonnes of salt per year and the CIL Inc. chlor-alkali plant uses 65 000 tonnes of salt per year.

The entire output of St. Anne Chemical Company Ltd. is used by the St. Anne-Nackawic pulp and paper mill. In addition, the mill buys caustic soda from other sources. The output from CIL Inc. is sold to several users, mainly pulp and paper mills*, within the Atlantic region. Most of the sales are in New Brunswick and the Gaspé as Nova Scotia has its own chlor-alkali plant at Abercrombie Point and Maine has a plant at Orrington.

It seems reasonable to assume that almost all demand for salt and chlor-alkali chemicals is met with local product (salt: Sussex, Nappan or Pugwash).

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*Most caustic soda is used in the kraft or sulfate pulp process. Makeup caustic is required at the rate of about 5 kg per ton of pulp. An average sulfate mill would use 5 000-10 000 tonnes of caustic per year.

Road salt. The New Brunswick Department of Transportation uses 110 000 tonnes of road salt annually. Consumption by New Brunswick's largest cities and towns is likely in the order of 15 000 - 20 000 tonnes.

Total. The total consumption of salt in New Brunswick is:

Chlor-alkali	85 000	tonnes
Roads	125 000 - 130 000	
Miscellaneous (fish, feed, food)	5 000	
Total	215 000 - 220 000	tonnes

Consumption for Nova Scotia is likely 150 000 tonnes and Maine 250 000 tonnes.

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TITANIUM DIOXIDE

T I T A N I U M D I O X I D E

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TITANIUM DIOXIDE

1.0 INTRODUCTION

Definition. Titanium oxide or titania is found naturally in the mineral, rutile (TiO_2 with iron). As well, it is produced from processing of other titanium ores such as ilmenite ($FeTiO_3$) and anatase (TiO_3). (TD 1)

Special properties. Titanium oxide is a widely-used white pigment with good light-reflection opacity and covering properties. Its key property is high index of refraction (rutile = 2.76, anatase = 2.55).

Considerable processing of titanium minerals is required to produce pure titanium dioxide and enhance its pigment properties. The two main pigment-enhancing processes are the sulphate process and the chloride process. The chloride process is displacing the sulphate process because it has fewer waste products (the chlorine reagent is recycled) and lower waste disposal costs. However, the chloride process also requires a higher grade of feedstock.

2.0 PRODUCTION STATUS IN NEW BRUNSWICK

Occurrences of titanium dioxide in the Province have recently been reviewed. (TD 5) An occurrence in the Taylor Village area has been explored in the past and is regarded as warranting additional evaluation. Exploration and development is not being actively pursued at present.

3.0 CONSUMPTION

In Canada, the major uses of titanium dioxide are paint (60 percent), plastics (15 percent), paper (13 percent), and rubber, ink, textiles and ceramics (1986). In the United States the leading uses in 1985 were paint, varnish, lacquer (54 percent), paper (20 percent), plastics (16 percent) and rubber, ink, and ceramics. (TD 1, TD 2)

Canadian consumption of titanium dioxide was 0.080 tonnes (M) in 1986, American consumption was 0.880 tonnes (M) in 1985.

3.1 Paint

Description. Titanium dioxide is the best selling white pigment due to its low unit cost of hiding power (square metres per kilogram of pigment). Exterior paints, enamels, and lacquers all use titanium dioxide; a typical exterior white paint, for example, contains 40 percent pigment of which 60 percent is titanium dioxide, 25 percent fillers (mica, silica, calcium carbonate), and 5 percent zinc oxide. (TD 3)

Companies and locations. See Diatomite.

Sources and suppliers. There are now four major titanium dioxide pigment producers in the Western World:

E.I. du Pont de Nemours and Company
Tioxide International Ltd. (Tioxide)
NL Chemicals Inc. (NLC)
SCM Corporation (SCM)

Titanium dioxide pigment plants in Canada and the United States are listed in Table 1.

TABLE 1

TITANIUM DIOXIDE PIGMENT PLANTS IN CANADA AND THE UNITED STATES
(TD 1, TD 2)

Province/State	Company	Location	Process	Capacity t/a
Quebec	NL Chem Canada, Inc.	Varennes	sulphate	—
	Tioxide Canada Inc.	Tracy	sulphate	—
	NL Chem Canada, Inc.	Varennes	chloride	38 000
Maryland	SCM Corp., Glidden Pigments Group	Baltimore	chloride sulfate	45 000 60 000
Ohio	SCM Corp., Glidden Pigments Group	Ashabula	chloride	89 000
Delaware	E.I. du Pont de Nemours & Co. Inc.	Edge Moore	chloride	100 000
Tennessee	E.I. du Pont de Nemours & Co. Inc.	New Johnsonville	chloride	210 000
Mississippi	E.I. du Pont de Nemours & Co. Inc.	DeLisle	chloride	135 000
	Kerr-McGee Chemical Corp.	Hamilton	chloride	57 000
Georgia	Kemira Inc.	Savannah	chloride sulphate	42 000 58 000
California	E.I. du Pont de Nemours & Co. Inc.	Antrioch	chloride	32 000

Specifications. Several processors "finish" titanium dioxide for paint consumption by coating the pigment particles with materials which reduce the absorption of ultraviolet light. Ultraviolet light speeds the deterioration of organic paint bases.

Prices. In recent years titanium dioxide has been in short supply. As a result prices have started to rise, by 3-4.5 percent in 1987, for example. July 1988 prices were (TD 4):

Titanium dioxide, anatase, bags 18 tonne lots, freight allowed	$2550/tonne
Titanium dioxide, anatase, slurry shipments, 45 tonne lots, dry basis, freight allowed	$2550/tonne
Titanium dioxide, rutile regular bags, 18 tonne lots, freight allowed	$2610-$2670/tonne
Titanium dioxide, rutile, slurry shipments, 45 tonne lots, dry basis, freight allowed	$2610-$2670/tonne

Non-chalking rutile costs $29.00/tonne more.

Substitutes. Lithopane (zinc sulfide) is another low cost, white pigment with good brilliance. However, lithopane is usually used in interior paints, not exterior. Barium sulfate is often used as a white pigment for rubber and paper coatings but has poor covering power and is only rarely used for paint.

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